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CURRENT BERYLLIUM LITERATURE: A SELECTED BIBLIOGRAPHY

JANUARY 1961 - DECEMBER 1962

Livermore, California

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Lawrence Radiation Laboratory, University of California
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January 1963

This bibliography is the result of a "current awareness" service performed by the American Society for Metals (ASM) under a purchase order with the University of California Lawrence Radiation Laboratory. The references[*] were gathered from the world's leading journals, books, technical reports, dissertations, and patents for the period January 1961 through December 1962.

In each section of this bibliography, books and journal articles appear first, arranged alphabetically by author. Anonymous articles are arranged alphabetically by journal name at the end of each grouping. These are followed by reports and patents arranged by report numbers. Translations are located in the groupings in accordance with their original form, i. e. , book, journal, etc. Because of diversity of subject content, some references are located in more than one section.

Many of the reports listed here are research and development reports released by the Atomic Energy Commission, Army, Navy, Air Force, and agencies of the Federal Government and their contractors. Most of these reports are available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

[*] References were typed from citations provided by ASM. LRL did not edit the ASM citations except for obvious typographical errors.

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SECTION I

CHEMISTRY OF BERYLLIUM

Apple, R. F. and J. C. White (Oak Ridge National Lab., Tenn.)
SEPARATION AND CALORIMETRIC DETERMINATION OF TRACE QUANTITIES OF MAGNESIUM IN HIGH-PURITY BERYLLIUM OXIDE. Talanta, 8: 419-25 (June 1961)

Balaban, A. T., E. Barabas, and M. Farcasiu
DIACETYLATION OF 2-METHYLBUT-2-ENE CATALYSED BY BERYLLIUM CHLORIDE. Chemistry & Industry, no. 17: 781-782 (April 1962)

Production of isomeric pyrylium salts-2,3,4,6 tetramethylpyridine and 2,6 dimethyl-4-ethylpyridine by diacetylation of 2 methylbut 2-ene, using beryllium chloride as catalyst. Steps in process include reflux heating, hydrolyzing and extracting. Beryllium chloride yields 97% of tetramethylpyridine.

Berger, G. S. and I. I. Levin
EXPERIMENTAL SEPARATION OF TANTALITE CONCENTRATES IN CAPACITOR WITH LIQUID DIELECTRIC. Izvestyia Akademii Nauk SSSR, OTN, Metallurgiya i Toplivo: 115-117 (April 1961) (Russian)

Cubicciotti, Daniel
ENERGIES OF THE GASEOUS ALKALINE EARTH HALIDES. Journal of Physical Chemistry, 65: 1058-1059 (June 1961)

Determination of binding energies from values of internuclear distance, overlap repulsion and coulombic energies in empirical expressions. Data are given for experimental values of the energy of formation from infinitely separated ions.

Hardy, C. J. and D. Scargill
THE DISSOLUTION OF BERYLLIUM IN AQUEOUS SOLUTIONS OF MINERAL ACIDS AND AMMONIUM FLUORIDE. Chemical Society Journal: 2658-2663 (July 1961)

Hibbits, J. O. and R. T. Williams
THE EXTRACTION AND DETERMINATION OF MOLYBDENUM AS THE THIOCYANATE COMPLEX. Analytica Chimica Acta, v. 26, no. 4: 363-370 (April 1962)

Determining the amount of Mo in steel and Be samples by forming a thiocyanate complex which is extracted using methyl isobutyl ketone. Effect of Rh, Ru, Pt, Pd, Se and Te on the Mo absorbance spectrum.

Hyde, K. R., P. L. Robinson, M. J. Waterman, and J. M. Waters (Atomic Energy Research Establishment, Harwell, Berks, Eng.)
REACTION OF BERYL WITH SODIUM FLUOROSILICATE USED IN EXTRACTING BERYLLIUM FROM THE MINERAL. Bull. Inst. Mining Met., 70: 397-406 (April 1961)

Kida, K, M. Abe, S. Nishigaki, and Takeshi (Nippon Gaishi Co., Ltd.)
COLORIMETRIC RAPID DETERMINATION OF SILICON IN COPPER-BERYLLIUM ALLOYS. Bunseki Kazaku, 10: 358-62 (April 1961) (Japanese)

Kida, K. , M. Abe, S. Nishigaki, and K. Kobayashi
COULOMETRIC DETERMINATION OF Be IN Be-Cu AND Be-Al ALLOYS. Japan Analyst, v. 9: 1031-1035 (December 1960)
Determination of Be with 8-hydroxyquiraldine in alloy specimens containing 1-5% Be using KCN for masking Cu and EDTA for masking Al. Effect of masking agents on the absorbency of the Be complex.

Lindsay, H. M. , V. D. Scott, and A. Moore
SELECTIVE DECORATION OF FINE STRUCTURAL EFFECTS IN BERYLLIUM. Less-Common Metals Journal, v. 3: 407-411 (October 1961)

Mezhiborskaya, Kh. B.
RADIOACTIVATION METHOD FOR THE DETERMINATION OF BERYLLIUM IN MINERAL RAW MATERIALS AND IN HYDROMETALLURGICAL PRODUCTS. Journal of Inorganic Chemistry, v. 15: 323-328 (May-June 1960)
The determination of Be by a radio activation technique with attention to control of effects distorting analytical results because of self-absorption of photoneutrons and gamma-ray absorption.

Mudrolyubova, L. P.
REACTION OF $ZrTiO_4$ WITH METAL OXIDES OF ELEMENTS OF MENDELEEV GROUPS II, III, AND IV AT ELEVATED TEMPERATURES. Zhur. Priklad. Khim., 34: 1679-90 (August 1961) (Russian)

Nesterenko, E. G. and K. V. Chuistov
EFFECT OF SMALL, BERYLLIUM, SILVER, ZIRCONIUM, CHROMIUM AND IRON ADDITIONS ON DECOMPOSITION OF COPPER-TITANIUM SOLID SOLUTIONS. Fizika Metallov i Metallovedenie, v. 12: 567-575 (April 1961) (Russian)
Effect of additives and of heat treatment time and temperature on solid solution decomposition as determined by X-ray diffraction and hardness measurements.

Pointu, P. , L. Espagno, P. Azou, and P. Bastien (École Centrale des Arts et Manufactures, Paris)
STUDY OF THE PRECIPITATION OF TRACE IMPURITIES IN BERYLLIUM. Compt. rend., 250: 2365-7 (March 1960) (French)
The precipitation of trace impurities (especially the transition elements) in beryllium was studied by radiocrystallography, resistivity measurements, micrography, and electron microprobe. One precipitate studied has an orientation relationship with the matrix. (tr-auth)

Samsonov, G. V. , G. A. Yasinskaya, and E. A. Shiller
THE REACTION OF CERTAIN OXIDES AND CARBIDES WITH REFRACTORY METALS AT HIGH TEMPERATURES. Translated from Ogneupory, No. 7: 335-8 (1961) 7p. (FTD-TT-61-74)
BeO, MgO, ZrO_2 and carbides of Zr, Hf, Cb and Ta in contact with Cb, Mo and W are studied at temperatures to 2100°.

Sato, H. , and R. S. Toth
EFFECT OF ADDITIONAL ELEMENTS ON THE PERIOD OF CuAuII AND THE ORIGIN OF THE LONG-PERIOD SUPERLATTICE. Physical Review, v. 124: 1833-1847 (December 1961)

Scaife, D. E. and A. W. Wylie
THE PREPARATION OF THORIUM CARBIDE AND SOME ASPECTS OF THE HIGH TEMPERATURE DECONTAMINATION OF IRRADIATED CARBIDE FUELS. Australian Atomic Energy Symposium: 172-181 (1958)

A study is made of factors influencing the synthesis of ThC_2 from ThO_2 and C and the volatilization of Be, Cd, Ce, Eu, Fe, Nb, P and Sr from ThC at 2150°C. Radiometric, colorimetric, fluorimetric, and flame photometric techniques are used to follow the volatilization of impurity elements from the carbide above 2000°C.

Serdyuk, L. S. and G. P. Federova
INVESTIGATION OF THE REACTION OF BERYLLIUM WITH ALUMINON. Translated by H. J. de Bruin from Ukrain. Khim. Zhur. 3: 384 (1958) 7 p. (AAEC/Trans-2)

The complex formation reaction between beryllium and aluminon was investigated for different values of pH. It was established that at pH between 4 and 5 a complex is formed containing the constituents in the ratio 1:1. At a pH between 7 and 8 a complex is formed having a beryllium-aluminon ratio of 3:1. At pH 6 both complexes are formed. It is shown that the complexes can be distinguished optically and in other aspects. The colorimetric determination of beryllium with aluminon is made at pH 5. At this pH value the results obtained for the determination of beryllium are satisfactory and are of sufficient reproducibility.

Smirnov, M. V.
RESIDUAL CURRENTS AND CATHODIC DEPOSITION OF METALS FROM MOLTEN SALTS. Translated from p. 3-5 of "Electrochemistry of Molten and Solid Electrolytes." New York, Consultants Bureau, Inc., 1961.

Study of molten salt mixtures of Ti, Zr, Hf, Th, U, Cb and Ta for metallic deposition at 600°C and the effect of temperature on cathodic yield. Theoretical discussion of residual currents led to a cathodic deposition equation.

Straumanis, M. E.
VALENCY OF IONS FORMED DURING ANODIC DISSOLUTION OF METALS IN ACIDS. Electrochemical Society Journal, v. 108: 1087-1092 (December 1961)

The charge of cations expelled by a metallic electrode in acidic aqueous solutions while under an anodic current is computed from the current applied and the total hydrogen evolution rate after the initial self-dissolution rate is subtracted. Phonomena occurring in dissolution of Ti, Fe, Zr, Zn, Mg, Al, Be and Hf are related to self-dissolution, dissolving surface activation, protective film breakdown and formation of metal fragments.

Straumanis, M. E. and D. L. Mathis
THE DISSOLUTION REACTION AND ATTACK OF BERYLLIUM BY Hf, HCl AND H_2SO_4. Electrochemical Society Journal, v. 109: 434-436 (May 1962)

AD-239346

Lockheed Aircraft Corp., Sunnyvale, Calif.
BERYLLIUM ANALYZED FOR TRACE IMPURITIES BY GAMMA-RAY ACTIVATION. W. Bradshaw, R. Johnson, and D. Beard. January 1960, lv. incl. ullus. tables. (Rept. No. LMSD-288231) (Contract NOrd-17017)

Investigations were undertaken to develop a method for the analysis of trace quantities of oxygen, carbon, and nitrogen in high-purity beryllium. The gamma-ray activation method for beryllium has been used, with a precision of 20 percent, to detect trace quantities of 10 to 5000 ppm oxygen and 100 to 25,000 ppm carbon. For high-purity material, and in the absence of other interfering activities, the minimum amount of oxygen and carbon detectible is expected to be 1 ppm with a precision of ±5%. The method could be used to estimate nitrogen content, when the Fe and Cu contents of the sample are accurately known. The technique is used as a reference method for the development of ultra-high-purity beryllium and as a standard method for the evaluation of analytical techniques for oxygen. It is the only method available for the analysis of carbon contained in beryllium in the range of 10 to 1000 ppm. To activate a beryllium sample, the technique uses gamma rays produced in a linear accelerator. The resultant oxygen and carbon activities decay through positron emission which can be detected by a coincidence-counting technique. The consequent decay curve consists primarily of three activities: O, C, and a tricomponential activity of Fe, Cu, and N. Interference from other elements is negligible in most of the samples so far analyzed. In the analysis of very low quantities of O, C, or N, interference from other elements can be minimized by using a triple-coincidence counting technique or by varying the bombarding energy.

AD-259588

Aerospace Technical Intelligence Center, Wright-Patterson Air Force Base, Ohio
INVESTIGATING THE NATURE OF SECONDARY CHEMICAL BONDS.

Correlation of theoretical and experimental Ir spectroscopic investigations into the nature of secondary chemical bonds, particularly those promoting metalorganic bonds of Li, Be, B and Al.

AD-261000

Ledoux and Co., Inc., Teaneck, N. J.
OXYGEN IN BERYLLIUM. REPORT FOR MARCH 1, 1959-FEBRUARY 29, 1960, ON MATERIALS ANALYSIS AND EVALUATION TECHNIQUES. Silve Kallmann and Fred Collier. December 1960. 17 p. (WADD TR 60-185) (Contract AF 33(616) 6281, Proj. 7360)

Applications of the inert gas fusion method using a Ni flux and the bromine-methanol method based on differential solubility to the determination of oxygen in Be.

AD-262730

University of Southern Calif., Los Angeles
THE ABSORPTION COEFFICIENTS OF THE ALKALI METALS AND THE ALKALI EARTHS. Robert D. Hudson

Review of absorption coefficient data and new experimental results for Na at 1800-1080Å.

AD-265625

Brush Beryllium Co., Cleveland, Ohio
INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. REPORT FOR MAY 1, 1959-OCTOBER 31, 1960, ON CERAMIC AND CERMET MATERIALS DEVELOPMENT. Jonathan Booker, Robert M. Paine and A. James Stonehouse. April 1961. 133p. (WADD TR 60-889) (Contract AF 33(616) 6540, Proj. 7350).

Investigation of $TaBe_{12}$, Ta_2Be_{17}, Hf_2Be_{21}, $MoSi_2$, $TaSi_2$ and WSi_2 for structural material applications above 2500°F. Determination of activation energy for a cubic rate process and oxidation rates of $TaBe_{12}$, Hf_2Be_{21}, $ZrBe_{13}$ and Ta_2Be_{17} from 2300-2750°F.

AERE/X/PR-2510/16

Exeter, England. Univ.
THE REACTION OF BERYLLIUM AND SOME OTHER METALS WITH CARBON DIOXIDE AT ELEVATED TEMPERATURES. R. J. Hussey. 1960.

Determination of chemistry and kinetics of oxidation reactions of Be and Zr with CO and CO_2 at 500 to 750°C.

APEX-531

General Electric Co., Aircraft Nuclear Propulsion Dept., Cincinnati
BERYLLIUM OXIDE HYDROLYSIS. M. E. Lapides, R. J. Opera, M. J. Mullikin, and J. H. King. December 1956. 26p. (Contracts AF 33(600) -38062 and AT (11-1)-171)

APEX-684

General Electric Co., Flight Propulsion Lab. Dept., Cincinnati
BASIC MATERIALS STUDIES: SINTERABLE HIGH PURITY BeO. FINAL REPORT. W. J. Kirkpatrick, G. R. Anderson, and E. S. Funston. June 30, 1961. 45p. (Contracts AF 33(600)-38062 and AT (11-1)-171)

BM-RI-5941

Bureau of Mines. Salt Lake City Metallurgy Research Center
SOLVENT EXTRACTION OF BERYLLIUM FROM SULFATE SOLUTIONS BY ALKYL-PHOSPHORIC ACIDS. R. O. Dannenberg, D. W. Bridges, and J. B. Rosenbaum. June 1961. 18p.

Organophosphate solvent extraction of Be from sulfate leach liquors.

CEA-tr-X-257

PROCEDE DE FABRICATION D'ALLIAGES LEGERS AU BERYLLIUM ET DE BERYLLIUM PUR (CLASSE III). (PROCEDURE FOR FABRICATION OF LIGHT ALLOYS OF BERYLLIUM AND OF PURE BERYLLIUM (CLASS III).) Translated into French from Italian Patents 348,085, October 19, 1936 and 351,374, April 29, 1937. 27p.

Fabrication of low fusion point light Be alloys and pure Be by uniting Li, Na, Mg, K, Ca, Ru, Sr, Ce, Ba, B, C, and Si.

CEA-tr-X-258

PROCEDE DE FABRICATION DU BERYLLIUM OU DES ALLIAGES DE BERYLLIUM. (FABRICATION PROCEDURE FOR BERYLLIUM OR BERYLLIUM ALLOYS). Translated into French by L. Roulet from Italian Patent 350,669. April 29, 1937. 25p.

Fabrication of Be alloys by replacement of fluorinated compounds by more electropositive metals or metalloids.

CEA-1568

Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France
METHOD OF SEMIQUANTITATIVE DETERMINATION OF BERYLLIUM IN ROCKS AND SOILS BY PAPER CHROMATOGRAPHY. H. Agrinier. December 1960. (French)

Separation by ascending paper chromatography using an acetone and nitric acid solvent and a quinalizarin indicator.

HW-68512

General Electric Corp., Hanford Atomic Products Operation, Richland, Wash.
FUEL CLOSURES-BRAZE LAYER REACTIONS TRANSMUTATIONS, DIFFUSION AND COMPOUND FORMATION. S. H. Bush. February 1961.

Investigation of reactions occurring in the cladding-fuel interfacial zone of Zr-5 wt% Be, X-800, Aluminum, AISI and Cu during irradiation to determine penetration values, phase thickness and nuclear transmutations.

IGO-AM/S-150 (2nd Ed.)

United Kingdom Atomic Energy Authority. Industrial Group. Springfields Works, Springfields, Lancs, England
THE DETERMINATION OF FREE CARBON IN BERYLLIUM METAL (BY IGNITION WITH A GASOMETRIC FINISH). March 3, 1959. 10p.

The beryllium sample is dissolved in sulfuric acid. The solution is filtered and the residue is washed, dried, and ignited in a stream of oxygen. The carbon dioxide produced is measured gasometrically.

NAS-NS-3013

Washington. Univ., Seattle. Department of Chemistry
THE RADIOCHEMISTRY OF BERYLLIUM. A. W. Fairhall. May 1960. 58p.

NBL-165

Atomic Energy Commission. New Brunswick Lab., N. J.
SEMI-ANNUAL PROGRESS REPORT FOR THE PERIOD JANUARY 1960 THROUGH JUNE 1960. C. J. Rodden. January 1961. 68p.

Modifications were made in the Carlson and Banks procedure for the spectrophotometric determination of silicon in beryllium metal and oxide. The refractory oxide is dissolved directly in hydrofluoric acid. The identical procedure is used for metal after ignition to the oxide. Concentrations of beryllium over certain limits have a quenching effect on the fluorescence of the aluminum-Pontachrome Blue Black R complex. The determination of trace amounts of aluminum in beryllium can be carried out despite this quenching effect by the method of standard addition. Samples of plutonium sulfate tetrahydrate prepared 9 to 12 months earlier were under investigation to determine the suitability of this compound as a primary analytical standard of plutonium. The compound was determined experimentally to contain four molecules of water of crystallization. Plutonium sulfate tetrahydrate was found to lose a major portion of its water of crystallization when heated at 115°C. Indications, but no conclusive evidence, of the existence of another intermediate hydrate of plutonium(IV) sulfate, were found. Microscopic examination of 1-year-old crystals of $Pu(SO_4)_2 4H_2O$ shows no evidence of the effect of any α radiolysis on the water of crystallization. Continued exposure to a fluctuating atmosphere caused no apparent changes

in crystal structure or weight. Heating $Pu(SO_4)_2 4H_2O$ to 325°C produced a dehydrated salt of weight equivalent to the formula, $Pu(SO_4)_2$. This material, although slightly hygroscopic, can be readily dried at 120°C and appears to be satisfactory for further investigation of its suitability as an alternate primary standard of plutonium. A method is presented for the rapid determination of milligram quantities of sulfate in pure plutonium sulfates. Plutonium is adsorbed on a cation resin and an acidimetric titration is made of the displaced hydrogen ion which is equivalent to the sulfate content of the sample. A technique used for the prevention of plutonium hydrolysis in neutral solution is described. The method may be applied to the determination of sulfate in any pure plutonium sulfate. A method is described for sampling and analyzing uranium in graphite waste. Sampling data indicate that representative sampling is obtained if the material is pulverized to less than 30-mesh size before reducing to 20 to 50-g portions for analysis. A HNO_3 (1-3) digestion is sufficient for extracting the total uranium in the waste material. Details for the preparation of synthetic scrap solutions of uranium-aluminum, uranium-stainless steel, and uranium-Zircaloy-2 are presented. Methods of analysis are described and precision data given for the determination of uranium in these solutions. Further evaluation of the isotopic abundance of uranium by mass spectrometric determination was made, and comparisons are shown for National Bureau of Standards and New Brunswick Laboratory values of standard sample NBS-U-200.

NCL/AE-198

Great Britain National Chemical Lab., Teddington, Middx., England
THE DETERMINATION OF MICROGRAM QUANTITIES OF URANIUM IN SOME BERYLLIUM MATERIALS. G. H. Smith and D. C. Harvard.

Break down or dissolution of samples and separation of uranium by solvent extraction for subsequent fluorometric measurements of trace quantities of U in Be.

NMI-2078

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR MAY 1959. July 1959. Decl. September 1960. 41p.

NP-9553

Brussels. Centre d'Étude de l'Énergie Nucléaire
METALLURGIE-RAPPORT D'ADVANCEMENT, DEUXIEME TRIMESTRE. (METALLURGY PROGRESS REPORT, SECOND QUARTER). September 1960. 80p.

BR-1 Fuel Elements. A method is described for welding Iron-Constantan thermocouples to BR-1 fuel elements. Stabilization procedures are given for nonalloyed Belgian uranium, and for stabilization by alloying with niobium-chromium, and molybdenum-zirconium. An experimental study was made of the recrystallization of Belgian uranium. Corrosion of magnesium alloys was studied. Aluminum was investigated as a cladding material. BR-2 Fuel Element. The studies reported include fabrication of aluminum-uranium, casting the "Triplex" element, sandwich lamination, preparation of aluminum/uranium-aluminum/aluminum plates, and nondestructive testing of plates and elements. REBUS Fuel Element. Progress is reported on thermocouple attachment

and surface treatment for REBUS fuel elements. Pyrometallurgical Reprocessing. Preliminary work in melt refining is reported. Knowledge of Materials. An extensive tabulation is presented of operating conditions found in the literature for extraction of gases (H_2, N_2O_2) and from steels, Fe, Al, Be, Cr, Cu, La, Mn, Mo, Ni, Co, Si, Ta, Th, Ti, U, V, W, and Zr. Progress is also briefly reported on hot laboratory materials research and pile irradiation experience.

NP-9639 (Vols. 1 and 2)
Dow Chemical Co. Thermal Lab., Midland, Mich.
JANAF INTERIM THERMOCHEMICAL TABLES. VOLUMES 1 AND 2. T. E. Dergazarian, N. J. Dumont, L. A. du Plessis, W. E. Hatton, S. Levine, R. A. McDonald, F. L. Oetting, H. Prophet, G. C. Sinke, D. R. Stull, and C. J. Thompson. December 1960. (Contract AF 33(616)-6149)

These two volumes were issued separately, but are cataloged as a unit.

A comprehensive set of thermochemical tables is presented for rocket performance calculations. The tables include data on compounds of Al, B, Be, Ti, Zr, and a number of other compounds.

ORNL-3183
Oak Ridge National Lab., Tenn.
THE CALCINATION IN AIR OF BERYLLIUM OXALATE TRIHYDRATE TO BERYLLIUM OXIDE. R. L. Hamner and L. A. Harris. October 1961. 16p. (Contract W-7405-eng-26)

ORNL-3220 (Pt. 1)
Oak Ridge National Lab., Tenn.
DISSOLUTION OF BeO- AND Al_2O_3-BASE REACTOR FUEL ELEMENTS. PT. 1. K. S. Warren, L. M. Ferris, and A. H. Kibbey. February 1962. 24p. (Contract W-7405-eng-26)

Patent - U. S. 2,982,644
PROCESS FOR THE MANUFACTURE OF BERYLLIUM. Jonas Kamlet. May 1961.

PG-Report-171 (p. 25-41)
Great Britain National Chemical Lab., Teddington, Middx., England
METHODS OF BERYLLIUM DETERMINATION USED AT THE NATIONAL CHEMICAL LABORATORY. E. C. Hunt and J. V. Martin

PG-Report-171 (p. 81-92)
United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England
THE DETERMINATION OF OXYGEN IN BERYLLIUM BY VACUUM FUSION AND BY CHEMICAL METHODS. A. Parker

PG-Report-171 (p. 93-117)
United Kingdom Atomic Energy Authority. Production Group. Chemical Services Dept., Springfields, Lancs, England
THE DETERMINATION OF IMPURITIES IN BERYLLIUM BY CHEMICAL OR NEUTRON ACTIVATION ANALYSIS. R. Todd

Investigation of neutron activation methods for determining Na and uranium impurities and evaluation of chemical methods in terms of speed and precision.

PG-Report-172

United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England
THE DETERMINATION OF IMPURITIES IN BERYLLIUM BY ACTIVATION ANALYSIS USING REMOTE REACTOR FACILITIES. A. P. Seyfang and R. Todd. 1961.

Procedure used, equipment required and precision attained for neutron activation analyses.

PG-Report-268

United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England
ANALYTICAL METHOD FOR THE DETERMINATION OF PHOSPHORUS IN BERYL ORE. 1961. 6p.

WADD-TR-60-543

Metal Hydrides Inc., Beverly, Mass.
ATTEMPTED SYNTHESIS OF BERYLLIUM HYDRIDE. John C. Powers, Donald W. Vose, and Edward A. Sullivan. October 1960.

Direct synthesis of hydrides of Be and Mg from the elements using equipment designed to grind the metal while subjected to heat and hydrogen pressure.

Y-1321

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
THE CONDUCTOMETRIC DETERMINATION OF CARBON IN BERYLLIUM. E.M. Massey. October 1960. 21p. (Contract W-7405-eng-26)

A method of analysis for trace quantities of carbon in beryllium is described which involves combustion of the sample together with accelerators in an oxygen atmosphere using an induction type furnace. Carbon, released as CO_2, is measured using a BaOH conductivity cell.

Y-1324

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
ANALYTICAL METHODS IN THE BERYLLIUM PROGRAM. J.M. Googin. December 1960. 12p. (Contract W-7405-eng-26)

Y-1329

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
THE DETERMINATION OF THORIUM AND URANIUM AS TRACE IMPURITIES IN BERYLLIUM METAL. W. C. Dietrich. December 1960. 19p. (Contract W-7405-eng-26)

A method for the determination of microgram quantities of thorium and uranium in beryllium metal was developed. Both thorium and uranium are separated from beryllium in a nitrate system by a tri-n-octylphosphine oxide extraction. Thorium is subsequently re-extracted from the organic phase into 0.3$\underline{M}$ sulfuric acid and is determined colorimetrically by thoron. Uranium remains in the organic phase and is determined directly by a fluorophotometric method.

Y-1377

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
A DISSOLUTION STUDY OF HIGH FIRED $BeO-UO_2$ CERAMICS BY FUSION. F. W. Postma, Jr. and R. E. Barringer. December 1961. 12p. (Contract W-7405-eng-26)

High fired $BeO-UO_2$ ceramic is dissolved by fusing with Na_2O_2 in dilute HNO_3 at 650°C.

SECTION II

PHYSICS OF BERYLLIUM

Adamovich, M. I., N. M. Panova, V. M. Popova, F. R. Yagudina
RATIO OF CROSS SECTIONS FOR PRODUCTION OF NEGATIVE AND POSITIVE PHOTOMESONS IN BERYLLIUM. Soviet Physics: Journal of Experimental and Theoretical Physics, v. 12; 1103-1105 (June 1961)

Measurement of the ratio of the yields of the charged mesons emitted at 90° to a photon beam irradiating a Be target. Spectrum of the photons is a bremsstrahlung one with maximum energy of 250 MeV. Energy spectra of the mesons are obtained in the energy range 12 to 40 MeV. Ratio of the cross sections for photo production of pi positive and pi negative mesons.

Albert, R. D., S. D. Bloom, and N. K. Glendenning
(p,n) ANGULAR DISTRIBUTIONS FROM MIRROR NUCLEUS TARGETS: C^{13}, B^{11}, and Be^9. Physical Review, v. 122; 862-868 (May 1961)

Neutron angular distributions are measured using a long-counter detection technique in conjunction with the Livermore 90 inch variable energy cyclotron. The angular distribution changes slowly in the direction of increasing complexity with increasing energy, largely ignoring the occurrence of resonances except in their immediate vicinity.

Alburger, David E. (Oak Ridge National Lab., Tenn. and Brookhaven National Lab., Upton, N.Y.)
NUCLEAR PAIR EMISSION FROM THE 7.656-MeV LEVEL IN C^{12}. Physical Review, v. 118; 235-242 (April 1960)

The 7.656-Mev nuclear pair transition from the 0+ second excited state of C^{12} was observed in the $Be^9(\alpha,n)C^{12}$ reaction by means of an intermediate-image pair spectrometer. With a beam of 5.81-MeV alpha particles incident on a 0.7-MeV thick Be foil target the observed intensity ratio of the 7.656-MeV pair line to the 4.433-MeV pair line from the 2+ first excited state of C^{12} was $(5 \pm 1.5) \times 10^{-4}$. Approximately the same intensity ratio was found with both 5.38- and 5.81-MeV alpha particles incident on thick (6 mg/cm^2) Be targets. By applying the appropriate factors for the spectrometer efficiency and for the internal pair conversion coefficient of the 4.433-MeV transition the derived ratio of pair to total widths of the 7.656-MeV level is $\Gamma_{e\pm}/\Gamma = 8.2 \times 10^{-7} \times R$ where $R = N_{4.433}/N_{7.656}$, the ratio of neutron populations in the $Be^9(\alpha,n)C^{12}$ reaction. As a rough estimate R is assumed to be ~8 based on the only information available. This leads to $\Gamma_{e\pm}/\Gamma \sim 7 \times 10^{-6}$ which is a factor of ~15 smaller than estimates by Cook et al. in which the width Γ_α for the alpha-particle decay of the level was taken as 1/10 of the Wigner limit. The most plausible explanation of the data is that Γ_α is close to the Wigner limit.

Ammar, R., R. Levi Setti, and others (Enrico Fermi Inst. for Nuclear Studies, Univ. of Chicago, Ill.)
MESIC DECAYS OF HYPERNUCLEI FROM K CAPTURE BINDING ENERGIES. Il Nuovo Cimento v. 15; 181-200 (June 1959) Also issued as AFOSR TN 59-1025; AD-238741 (Contract AF 49(638)209)

The analysis of 134 uniquely identified mesic decays yields increased accuracy in the knowledge of the binding energies of the hypernuclides $^3H_\Lambda$, $^4H_\Lambda$, $^4He_\Lambda$, $^5He_\Lambda$, $^7Li_\Lambda$, $^8Li_\Lambda$, $^9Li_\Lambda$, and $^9Be_\Lambda$. In

addition, individual examples of the new species $^7He_\Lambda$, $^{11}B_\Lambda$, and $^{12}B_\Lambda$ are described. The present data are combined with those collected in the EFINS survey. The isotopic spin multiplet structure of the light hypernuclei is discussed with reference to the information derived from the binding energies.

Austin, Sam M.
THE POLARIZATION OF NEUTRONS FROM THE $Li^7(p,n)Be^7$ REACTION. The University of Wisconsin, 1960

The polarization of neutrons from the $Li^7(p,n)Be^7$ reaction was measured by observing the left-right asymmetry in the scattering of these neutrons from a liquid oxygen analyzer. A proton-recoil proportional counter was used to detect the neutrons. The analyzing power of oxygen for neutrons was calculated from phase shifts derived from previous total neutron cross section measurements.

Measurements were made at a reaction angle of 50° between 2.1 and 3.1 MeV. While earlier measurements were consistent with constant polarization between 2.1 and 4.5 MeV, the present measurements show a significant variation of the polarization as a function of energy. The experimental polarizations decrease rapidly from a value near +0.45 at 2.15 MeV to a broad minimum centered at 2.45 MeV, where the polarization is about +0.20 and then increases to a constant value near +0.30 for energies above 2.7 MeV.

Angular distributions of the polarization were measured at 2.2, 2.6, and 3.0 MeV; the angular ranges covered at these energies were 30° to 70°, 30° to 115°, and 30° to 70°, respectively. The angular distributions appear to be slightly peaked in the forward direction. At 2.6 MeV, the polarization is near zero at 105° and 115°.

The experimental data on the polarization and differential cross section do not agree with the results of calculations made assuming that parameters similar to those suggested by Macklin and Gibbons correctly describe the reaction. The inequality of the reduced widths for neutron and proton emission of the 3^+ level at 2.25 MeV can be explained in terms of the mixing by electromagnetic effects of states with the same J^π and different isotopic spin.

Azhgirey, L. S., I. K. Vzorov, V. P. Zrelov, M. G. Meshcheryakov, B. S. Neganov, R. M. Ryndin, and A. F. Shabudin
NUCLEAR INTERATIONS OF 660 MeV PROTONS AND THE MOMENTUM DISTRIBUTION OF NUCLEONS IN NUCLEI. Nuclear Physics, v. 13, No. 2; 258-280 (Oct. 1959)

An investigation is carried out of the angular distributions and, by magnetic analysis, of the energy spectra of secondary charged particles (mainly protons with energies $>\sim 60$ MeV) emitted at angles of 7°, 12.2°, 18°, 24°, and 30° in reactions of 660 MeV protons with nuclei of Be, C, Cu, and U. The cross-sections for emission of such secondary charged particles increase with decrease of the angles. In the order of decreasing energy the various spectral regions of all investigated elements correspond to diffraction scattering of protons on nuclei (in the small-angle region), single quasi-elastic proton—nucleon collisions, π-meson production on bound nucleons and nuclear cascade. The experimental energy spectra for single quasi-elastic proton—nuclear scattering are compared with the spectra computed in the impulse approximately under various assumptions regarding the momentum distributions of the nucleons in the nuclei. The Be and C data are consistent

with a Gaussian nucleon momentum distribution falling to 1/e at an energy of approximately 20 MeV. This means that the mean square value of the nucleon momentum in Be and C nuclei corresponds to an energy of ~30 MeV.

Balian, R. L. and V. P. Gillet
CALCULATION OF THE DIRECT INTERACTION IN THE REACTION $Be^9(n,2n)Be^8$. J. Phys. Radium, v. 19, No. 1; 10 (Jan. 1958) (In French)
Cross-sections are calculated for the knock-out process of the weakly-bound neutron of Be^9 by neutrons of 0-10 MeV, both particles being in the average potential of the nucleus.

Barber, W. C. and W. D. George
NEUTRON YIELDS FROM TARGETS BOMBARDED BY ELECTRONS. Physical Review, v. 116, No. 6; 1551-1559 (Dec. 1959)
The total neutron yields from thick targets bombarded by electrons were measured as a function of electron energy for the range 10 to 36 MeV. Targets ranging in thickness from one to six radiation lengths of C, Al, Cu, Ta, Pb, and U were used. The yields for 1- and 6-radiation-length targets of Pb at 34 MeV are 2.1×10^{-3} and 9.0×10^{-3} neutron/electron. Extrapolation to infinite target thickness gives a value of 9.5×10^{-3} neutron/electron. The yield, comparing targets of one radiation length from C is about 10 times smaller and that from U two times greater than the yield from Pb. An explanation of the relative z-dependence of the yield in terms of known photonuclear cross-sections is successful to within a factor of 1.5. The absolute accuracy of the results is estimated to be ±15%. Calibration of the neutron-detecting equipment was made with a RaBe source and checked by measuring the yields, due to electro- and photodisintegration of the deuteron, from a heavy-water target. In addition, yields from thin targets of Be and Cu were observed as a function of electron energy. The data for Be yield a value of (0.018 ± 0.003) MeV barn for the (γ,n) cross-section integrated to 17 MeV. The data for Cu were analyzed and combined with other measurements to give an approximate cross-section for the $Cu(\gamma,pn)$ reaction.

Beckner, E. H., R. L. Bramblett, G. C. Philips, and T. A. Eastwood
ABSOLUTE MEASUREMENT OF A SET OF ENERGY CALIBRATION STANDARDS. Physical Review, v. 123; 2100-2109 (Sept. 1961)
A 180° magnetic spectrometer is used to measure the energy of several neutron thresholds: $Li^7(p,n)Be$, $B^{11}(p,n)C^{11}$, $C^{13}(p,n)N^{13}$, and $F^{19}(p,n)$; gamma ray resonances: F^{19} (p, alpha ray and gamma ray) O^{16} and Al^{27} (p, gamma ray) Si^{28} and the energy of alpha particles emitted by Po^{210}.

Bernard, R., R. Goutte, C. Guillaud, and R. Javelas
POSSIBILITIES IN THE STUDY OF ADSORBING PROPERTIES OF A METAL BY SECONDARY IONIC EMISSION. Comptes Rendus des Seances de l'Academie des Sciences, v. 253; 1047-1049 (Aug. 1961) (In French)

Bevington, P. R., W. W. Rolland, and H. W. Lewis
RELATIVE YIELDS OF NEUTRON GROUPS FROM THE $Li^7(p,n)Be^7$ REACTIONS. Physical Review, v. 121; 871-876 (February 1961)
The relative yields of the two groups of neutrons from the Li^7 (proton, neutron)Be^7, excited Be^7 reaction, have been measured with

a time-of-flight system, using preacceleration pulsing of the accelerator beam. Absolute differential and total cross sections are calculated. The existence of three previously unidentified levels in Be^8 is suggested.

Bezrukov, L. S., D. A. Panov, and D. V. Timoshuk
THE $Li^7(d,p)Li^8$ CROSS-SECTION AS A FUNCTION OF DEUTERON ENERGY IN THE RANGE 1.1-4 MeV. J. Nuclear Energy, v. 4, no. 4: 521-523 (April 1957) English translation of article in Atomnaya Energiya, v. 1, no. 4: 149 (1956)
The β-activity of the Li^8 produced in a Li^7F target was measured during three successive intervals of 1 sec after a 1 sec deuteron exposure. Resonances at deuteron energiesof 2.0, 2.5, and 3.7 MeV correspond to levels in the Be^9 nucleus with energies 18.3, 18.7, and 19.6 MeV.

Bilwes, R., C. Gerardin, and D. Magnac-Valette
SPECTRUM OF THE ALPHA PARTICLES PRODUCED BY THE REACTION OF DEUTERONS ON ^{10}BORON AND THE EXCITED STATES OF ^{8}BERYLLIUM BETWEEN 0 AND 8 MeV. Comptes Rendus, v. 251: 2157-2159 (November 1960) (French)
Study of alpha particle spectrum of reaction on $^{10}B(d, alpha)^8Be$ with a magnetic spectrograph reveal only one excited state (2.9 MeV) in this range.

Blair, J. S.
PHOTODISINTEGRATION OF Be^9. Physical Review, v. 123: 2151-2153 (September 1961)

Bogdanov, G. F., N. A. Vlasov, S. P. Kalinin, B. V. Rybakov, and V. A. Sidorov
THE (p,n) REACTION ON LITHIUM AND THE GROUND STATE OF THE ^{6}Be NUCLEUS. J. Nuclear Energy, v. 8, no. 1-3: 148-155 (November 1958) English translation of article in Atomnaya Energiya, v. 3, no. 9: 204 (1957)
The time-of-flight method has been used to study the neutron spectra from the reactions of Li^6 and Li^7 with 9 MeV protons. Neutron groups were observed corresponding to transitions to the ground state of Be^6 and to the three lower states of Be^7, as well as a continuous distribution of low-energy neutrons due to more complex reactions. Observation of the group of neutrons from the reaction $Li^6(p,n)Be^6$ is the first experimental evidence of the existence of the Be^6 nucleus. The Q-value of the reaction $Li^6(p,n)Be^6$ is equal to -5.2 MeV and the width of the ground state of Be^6 is less than 0.3 MeV. The differential cross-sections for neutron formation were measured at angles of 0, 15, 30, 60, and 120°.

Bovin, V. V. and A. I. Mosharov
THE USE OF A GAMMA-RAY POCKET DOSIMETER FOR FAST-NEUTRON DOSIMETRY. J. nuclear Energy, v. 5, no. 3-4: 427-8 (1957). English translation of article in: Atomnaya Energiya, v. 2: 184 (1957)
The dosimeter was used near Be and Cu targets bombarded by 8-13 MeV deuterons from a cyclotron. In the first case neutrons accounted for 80%, in the second for 18% of the ionization. Its sensitivity was such that 6.5×10^6 fast neutrons/cm^2 corresponded to a reading of 25 mr ± 6%, the total error not exceeding 32% of which 26% was that in determining the neutron flux from the source. Self-discharge due to electrical leakage corresponded to a dose of 10-20 mr/month in the charged state.

Bredin, D. J., W. E. Burcham, D. Evans, W. M. Gibson, J. S. C. McKee, D. J. Prowse, J. Rotblat, and J. N. Snyder

THE SCATTERING OF ALPHA PARTICLES BY HELIUM. Proc. Roy. Soc. A. v. 251, 143-155 (May 1959)

In order to obtain information about the levels of even spin and parity of Be^8 at energies above 11 MeV, the differential cross-section for α-particle—helium elastic scattering was measured at a series of beam energies from 23.1 to 38.4 MeV, for many c.m.s. angles between 30 and 90°. Phase shifts up to L = 8 were calculated for each energy. Combining these results with previous figures for lower energies, the phase-shifts δ_0, δ_2, and δ_4 are thus known as functions of incident energy from 0.15 to 38.4 MeV. The behaviour of the phase shift δ_4 confirms the existence of a previously suggested level with I = 4 at an excitation energy of about 11.4 MeV in Be^8. The phase shifts δ_6 and δ_8 are small, as expected if the rotational series of levels in Be^8 terminates with I = 4.

Brown, Lynn B. and H. B. Knowles

ALPHA PARTICLES FROM Be^9 AND C^{12} BY MeV ALPHA-PARTICLE BOMBARDMENT. Physical Review, v. 125, 1339-1349 (Feb. 1962)

Determination of the alpha particle spectra from thin Be and carbon targets at 47.5° laboratory angle and an alpha energy of 25.41 MeV.

Callan, Edwin J.

ALL AUGER TRANSITION PROBABILITIES. Physical Review, v. 124, 793-799 (Nov. 1961)

Computation of transition rate, using screened nonrelativistic hydrogenic wave functions for a variety of atoms Z = 1 to Z = 80. Auger electron energies are derived from tabulated energy level values. K-shell fluorescence yields are computed and compared with other values.

Coleman, R. F.

THE DETERMINATION OF OXYGEN BY FAST NEUTRON ACTIVATION. Analyst, v. 87, No. 1036, 590-592 (July 1962)

Determination of oxygen in a mixture of BeO and Be, in steel, Zr, Ti, Cu, Al, Ta, W, Sn, Mo, V, and in Rh by fast neutron activation method which consists in producing nitrogen-16 by irradiation of $^{16}O(n,p)\,^{16}N$ with 14.5 MeV neutrons, and its detection by counting high energy gamma rays.

Dalgarno, A. and J. M. McNamee

CALCULATION OF POLARIZABILITIES AND SHIELDING FACTORS. Journal of Chemical Physics, v. 35, 1517-1518 (Oct. 1961)

Semi-empirical and theoretical determination of dipole and quadrupole polarizabilities, electric field strength at the nucleus and nuclear shielding factors of Be.

Dvir, M. and W. Low

PARAMAGNETIC RESONANCE AND OPTICAL SPECTRUM OF IRON IN BERYLLIUM. Physical Review, v. 119, 1587-1591 (Sept. 1960)

The paramagnetic resonance spectrum of Fe^{3+} in beryllium was measured at 20° and 290°K. In addition to this spectrum many weak lines were observed and possible explanations of these lines are discussed.

The optical spectrum shows a spectrum characteristic of trivalent iron. In the infrared region there are several groups of sharp lines whose origin is not yet known.

Elwyn, A. J. and R. O. Lane
POLARIZATION OF NEUTRONS IN SCATTERING FROM LIGHT NUCLEI AND THE $Li^7(p,n)Be^7$ REACTION. Nuclear Physics, v. 31, 78-117 (March 1962)

Neutrons scattered from Li^6, Li^7, Be^9, C^{12}, O^{16}, and Mg are measured to determine the scattering angles as a function of energy, polarization, scattering asymmetry, polarization peaks, peak widths, and resonance. Details of the corrections and errors relevant to the measurements and of their agreement with various theories.

Erskine, J. R. and C. P. Browne
ISOTOPIC-SPIN SELECTION RULE VIOLATION IN THE B^{10} (DEUTERON, GAMMA RAY) Be^8 REACTION. Physical Review, v. 123, 958-967 (Aug. 1961)

The ratio of the differential cross section for formation of the 16.62 and 16.92 MeV levels is measured from 35 to 50° at 4.005-3.865 MeV to test the isotopic-spin selection rule, free of spin and parity restrictions. Data are given on excitation energy, width and isotopic spin.

Farmer, B. J. and C. M. Class
ALPHA SPECTRA FROM THE DECAYS OF Li^8 AND B^8. Nuclear Phys., v. 15, No. 4, 626-635 (March 1960)

The spectra of alpha-particles accompanying the dissociation of Be^8, following the beta-decays of Li^8 and B^8, were measured. The spectra were found to be essentially identical, confirming the expected symmetry in the decay schemes of Li^8 and B^8. The spectrum associated with the decay of Li^8 was compared with that given by the modified single level of Wheeler (1941). The spectrum is not adequately accounted for by this formula if current values of the parameters are used to describe the 2^+ and 4^+ levels at 2.9 and 11.7 Mev in Be^8 which are assumed to be participating. An alternative description of the alpha-spectrum, involving only the 2^+ levels in Be^8 at 2.9 and 16.7 MeV, was given recently by Biedenharn and Griffy (see following abstract). Their expressions are found to be in agreement with the data over an energy range of more than 10 MeV, and hence may be taken as the preferred description of the process.

Gaadings, D. A.
EXCHANGE POLARIZATION EFFECTS IN HYPERFINE STRUCTURE. Physical Review, v. 123, 1706-1714 (Sept. 1961)

Gerritsen, H. J.
RECENT DEVELOPMENTS IN MASER DEVICES AND MATERIALS. Applied Optics, v. 1, 37-44 (Jan. 1962)

Crystal sizes, mechanical strength, dielectric constant, loss tangent, zero field splitting, spin lattice relaxation, pumping frequency, maximum operating temperature and characteristic emission data for maser crystals including lanthanum ethyl sulphate, potassium cobalticyanide, corundum, beryllium, rutile, cassiterite, calcium tungstate, and yttrium oxide. Doping impurities include Ce, Gd, Cr, and Fe.

Gordon, L. J.
HIGH TEMPERATURE EQUILIBRIA INVOLVING METALLIC HALIDES. ARS Journal, v. 30, 978-979 (Oct. 1960)

Gorodetzky, S., P. Chevallier, R. Armbruster, and G. Sutter (Institut de Recherches Nucléaires, Strasbourg)
ANGULAR CORRELATION OF INTERNAL CONVERSION PAIRS DETECTED IN A NEUTRON AND GAMMA BACKGROUND. APPLICATION TO N^{14}, Be^{10}, AND B^{10}. Nuclear Phys. 12, 349-355 (Aug. 1959) (In French)

The determination of nuclear electromagnetic transitions by angular correlations of internal conversion pairs is extended to reactions induced by deuterons. The neutron and gamma background is eliminated by the adjunction of thin crystals to the usual β scintillation spectrometer. This technique is applied to certain transitions in N^{14}, Be^{10}, and B^{10}.

Grainger, L.
THE BEHAVIOUR OF REACTOR COMPONENTS UNDER IRRADIATION. REVIEW SERIES, DEVELOPMENTS IN THE PEACEFUL APPLICATIONS OF NUCLEAR ENERGY, NO. 6. International Atomic Energy Agency, Vienna (1960) 62p.

The general nature of irradiation effects that are important to reactor components is discussed. The specific effects of irradiation on some of the most important materials are described; these materials include uranium metal, UO_2, UO, graphite, and structural metals, including steels and beryllium. The performance of certain key components under the influence of irradiation is discussed and some opinions are expressed regarding the industrial exploitation of atomic energy. Fuel elements are considered at greatest length; the limitations and development potential are assessed for fuel elements of various categories, including the Calder Hall type, those based on UO_2, and fuel elements for fast reactors and high-temperature gas-cooled reactors. In all these cases, future development seems promising. The behavior of structural components such as steel pressure vessels and graphite moderators is considered. It is concluded that better understanding will alleviate some of the current problems.

Grant, I. S.
RADIATIVE TRANSITIONS IN ^8Be. Proc. of the Physical Society, v. 76, 737-744 (Nov. 1960)

A measurement has been made of the angular correlation between the 14.7 MeV γ-radiation from the reaction $^7Li(p,\gamma)$ and the x-particles from the break-up of the 2.9 MeV excited state of ^8Be. The electric quadrupole to magnetic dipole amplitude ratio δ can be derived from the angular correlation. Under the assumption that the resonant component of the γ-radiation has an isotropic angular distribution, δ is found to be 0.21 ± 0.07. The predictions of the independent particle model, using a central force fitted to the properties of neighbouring nuclei, are in good agreement with the observed ratio δ and with the widths of both the 17.6 MeV and the 14.7 MeV transitions when the intermediate coupling parameter a/K is about 2.

Griffy, T. A. and L. C. Biedenharn
BETA DECAY INVOLVING THE $Be^{8*}(2^+)$ STATE. Nuclear Phys., v. 15, No. 4, 636-645 (March 1960)

The shape of the alpha- and beta-spectra in the $Li^8(\beta^-,\alpha)\alpha$ and $B^8(\beta^-,\alpha)\alpha$ decay is calculated directly from alpha – alpha scattering phase-shifts, using methods developed for this purpose, and the assumption that the decays involve only Be^{8*} in a (2^+) intermediate state. Recent experimental results are in good agreement with the calculated spectra.

Henley, E. M. and P. D. Kunz (Univ. of Washington, Seattle)
DECAY OF Be^9(2.43-MeV STATE). Phys. Rev., 118, 248-262 (April 1960)

The decay of the 2.43-MeV state of Be^9 is treated theoretically. Of the open two-body decay channels all but one involve a nuclear state, the energy of which is not well defined. The usual formalisms were generalized to take this into account. The estimate of the decay rates is made by means of a variational internal wave function for the Be^{9*} state, based upon the alpha-particle model. It is found that the principal mode of decay is to $He^5 + He^4$. Model – dependent arguments are given to show that decay to the ground state of Be^8 should be inhibited. Furthermore, the momentum and angular distributions of alphas emitted in the decay through several two-particle decay modes are computed. These latter calculations do not assume any specific nuclear model, but depend on the weak assumption that the state is excited by a direct reaction. Comparison with recent measurements indicates that in addition to the $He^5 + He^4$ decay, approximately 7% of the decay occurs to the ground state of Be^8, which is consistent with our calculations.

Hinds, S. and R. Middleton
AN INVESTIGATION OF THE PROTONS, DEUTERONS AND TRITONS FROM THE BOMBARDMENT OF ^9Be WITH 5.7 MeV ^3He. Proc. Phys. Soc., v. 74, Pt 2, 196-207 (Aug. 1959)

A thin beryllium target has been bombarded by 5.7 MeV He^3 particles and the charged reaction products analyzed with a high-precision broad-range magnetic spectrograph. Angular distributions of nine proton groups, four deuteron groups and a single triton group have been measured. Most angular distributions exhibit strong forward maxima suggesting that the reaction $B^9(He^3,p)B^{11}$, $Be^9(He^3,d)B^{10}$, $Be^9(He^3,t)B^9$, at least in part, proceed via a direct process.

Hisatake, Kazuo, Yoshihide Ishizaki, Akira Isoya, Teruo Nakamura, Yoshihiro Nakano, Bunsaburo Saheki, Yoshio Saji, and Kazunori Yuasa (Tokoyo University)
THE REACTIONS $Li^7(p,n)Be^7$, $B^{11}(p,n)C^{11}$, AND $Al^{27}(p,n)Si^{27}$ AT 8 TO 14 MeV. J. Phys. Soc., Japan 15, 741-748 (May 1960) (In English)

The (p,n) reactions for lithium, boron, and aluminum targets were studied using proton-recoil, fast-neutron spectrometers. The angular distributions of $Li^7(p,n)Be^7$ neutrons corresponding to the ground and the 0.43 MeV excited states at 8.1 to 14.1 MeV and corresponding to the 4.65 MeV excited state of Be^7 at 14.1 MeV were obtained. Using the activation method, the excitation curve of this reaction was observed with a 15-MeV proton beam. The angular distributions of neutrons from the reaction $B^{11}(p,n)C^{11}$ (the ground state) at 8.1 to 14.1 MeV and from the reactions $Al^{27}(p,n)Si^{27}$ (the ground and

the excited states) at 14.1 MeV were also observed. The theory of Austern, Butler, and McManus does not agree with the obtained results in the case of the reaction $B^{11}(p,n)C^{11}$, but agrees with that in the reaction $Al^{27}(p,n)Si^{27}$. It was observed that, for the reaction $B^{11}(p,n)C^{11}$, the isotropic parts of the angular distributions of neutrons became larger as the incident proton energies decreased and, in the cases of the reactions of $Li^7(p,n)Be^7$ and $B^{11}(p,n)C^{11}$, the angular distributions of neutrons showed large variations for the different proton energies.

Hobbie, Russell K., C. W. Lewis, and J. M. Blair
DIFFERENTIAL CROSS SECTIONS OF THE Be^9(Li^7, ALPHA RAY) B^{12} and Be^9(Li^6, ALPHA RAY) B^{11} REACTIONS. Physical Review, v. 124, 1506-1512 (Dec. 1961)
Absolute and differential cross sections are measured for the study of ground and excited states of Be^9 for alpha bombarding energies from 3.3 to 3.75 MeV with comparison of Rutherford scattering.

Hohn, H.
APPLICATIONS OF NUCLEAR MATERIALS IN NON-NUCLEAR FIELDS. The Industrial Challenge of Nuclear Energy, Stresa Conference, Pt. 3. Organization for European Nuclear Energy Agency, 91-107
Neutron cross section, present and projected production applications and costs are given for U, Pu, Th, B, Cd, Hf, Gd, Zr, Be, Mg, Al, Cd, H_2O, D_2O, Na, K, Bi, Ca, Mg, Co, In, and graphite.

Hon, J. F.
NUCLEAR QUADRUPOLE COUPLING CONSTANT OF Be^9 IN BeO. Physical Review, v. 124, 1368-1372 (Dec. 1961)
Determination of the quadrupolar coupling constant with zero asymmetry parameter from the splitting of the nuclear magnetic resonance time and observation of the anisotropic crystallite distribution in polycrystalline BeO.

Ignatenko, A. E.
ON TRANSITIONS BETWEEN HYPERFINE STRUCTURE LEVELS IN MU-MESIC ATOMS. Soviet Physics JETP, v. 11, 1093-1094 (Nov. 1960) (Translation)
The possibility of an experimental verification of the existence of transitions between hyperfine structure levels in mesic atoms is considered. A convenient method, in the case of mesic atoms possessing nuclear spins $J > 1/2$, is shown to be the measurement of the precession frequency of the mesic atoms.

Ishimatsu, Toshiyuki, Naoyuki Takano, Yuki Hachiya, and Takao Nakashima
ANGULAR DISTRIBUTIONS AND EXCITATION FUNCTIONS OF THE $Be^9(d,p)Be^{10}$ GROUND-STATE REACTION. Physical Society of Japan, Journal, v. 16, 367-371 (March 1961)
Angular distributions and excitation functions are measured as a function of deuteron energies from 1.7-3.03 MeV to determine forward peak characteristics and yields in the backwards directions.

Joanou, G. D., A. J. Goodjohn, and M. F. Wikner
MOMENTS CALCULATIONS OF THE FERMI AGE IN VARIOUS MODERATORS. American Nuclear Society, Transactions, v. 4, 278-279 (Nov. 1961)
Comparisons of theoretical calculations and measurements of neutron age in water, heavy water, kerosene, diphenyl, BeO, C, and metal water mixtures of Fe, Zr, and Al.

Johnson, Quintin C. and David H. Templeton
MADELUNG CONSTANTS FOR SEVERAL STRUCTURES. Journal of Chemical Physics, v. 34, 2004-2007 (June 1961)
Reduced Madelung constants are determined as functions of the reciprocal of the weighted-harmonic-mean coordination number for 38 structures.

Kavanagh, Ralph W. (California Inst. of Tech., Pasadena)
PROTON CAPTURE IN Be^7. Nuclear Phys. 15, 411-420 (March 1960)
Cross sections for proton capture by Be^7 measured at bombarding energies of 800 keV and 1400 keV are 0.48 ± 0.18 and 0.50 ± 0.20 μb, respectively, from which the corresponding cross section factors are $S = 0.027 \pm 0.010$ and 0.017 ± 0.007 keV·b. The reaction is important in stellar energy production only in stars operating on the proton-proton chain at temperatures greater than about 2×10^7 °K.

Komaishko, G. S., V. (B.) I. Matvienko, V. M. Permyakov, E. S. Soobbotin, and O. G. Feofilov
CONCERNING CERTAIN METHODS OF MASS-MANUFACTURE OF Po-α-Be NEUTRON SOURCES. Translated by W. E. Jones from Atomnaya Energ. 5, 64-67 (1958) 8p. (AWRE/Trans-U-61)

Kormer, S. B., V. D. Urlin, and L. T. Popova
INTERPOLATION EQUATION OF STATE AND ITS APPLICATION TO EXPERIMENTAL DATA ON IMPACT COMPRESSION OF METALS. Soviet Physics — Solid State, v. 3, 1547-1553 (Jan. 1962) (Translated from Fizika Tverdogo Tela, v. 3, (July 1961)
Interpolation equation of state in the form of a series in the density is proposed and its agreement with experimental impact compression data for Be, Mg, Al, Ni, Cu, Zn, Mo, Ag, Sn, Ta, W, Au, and Pb is evaluated. Calculation of the dependence of the Gruneisen constant on the density.

Kratochvil, J.
ELASTIC STRESS AROUND LINEAR DISLOCATION IN ANISOTROPIC MEDIUM. Czechoslovak Journal of Physics, v. 11, 324-335 (May 1961) (English)

Kul'chitskii, L. A. and V. Presperin
FAST PHOTONEUTRONS FROM Be^9, C^{12} AND Al^{27}. Zh. eksper. teor. Fiz., v. 37, No. 6(12), 1524-1529 (Dec. 1959) (In Russian)
The authors studied the angular distributions of photoneutrons with energies above 10 MeV emitted by Be^9, C^{12}, and Al^{27} targets irradiated with 88 MeV peak energy bremsstrahlung. The energy spectrum of photoneutrons emitted at an angle of 75° from C^{12} was also investigated and the data thus obtained were used to compare the photoneutron and photoproton yields in the same energy intervals. The angular distribution results are compared with the quasideuteron model and direct resonance nuclear photoeffect. Qualitative agreement with the quasideuteron model has been obtained.

Kuarath, Dieter (Argonne National Lab., Lemont, Ill.)
GAMMA WIDTH IN Be^8 PERTINENT TO A TEST OF THE CONSERVED VECTOR CURRENT THEORY. Phys. Rev. Letters 4, 180 (Feb. 1960)
The gamma transition width T_{M1} for the ($J = 2$, $T = 1$) ($J = 2$, $T = 0$) transition in Be^8 was calculated as a function of the relative strength of spin-orbit coupling to be 3 to 5 eV which approximately

corresponds to +0.10 Weisskopf units. The experimental value was previously determined to be +0.02 ± 0.04.

Lane, A. M.
REDUCED WIDTHS OF INDIVIDUAL NUCLEAR ENERGY LEVELS. Reviews of Modern Physics, v. 32, 519-566 (July 1960)
Theoretical prediction of reduced widths in terms of expansion coefficients and experimental values of reduced widths of resonance levels in light nuclei.

Leigh, J. J. and J. M. Blair
DIFFERENTIAL CROSS SECTIONS OF THE $Be^9(Li^6$, Alpha)B^{11} REACTION. Physical Review, v. 121, 246-252 (Jan. 1961)
The differential cross sections of the $Be^9(Li^6$, alpha particle)B^{11} reaction have been measured as a function of energy and angle. The angular distributions are asymmetric about 90° cm. Relative maximum occur at both large and small angles for each of the alpha-particle groups, with the yields at large angles being comparable to those at small angles. In all cases the angular distribution varies slowly with bombarding energy and the yields at each angle increase monotonically with increasing energy. The experimental results suggest that the reactions proceed mainly by direct-interaction mechanisms. The similarity of the angular distributions of the $Be^9(Li^6$,alpha ray)B^{11} and the $Be^9(He^3$, proton)B^{11} reactions is pointed out.

Leigh, J. J.
STRIPPING ANALYSIS OF THE $Be^9(Li^6$, ALPHA RAY) B^{11} REACTION. Physical Review, v. 123, 2145-2150 (Sept. 1961)
Analysis of the angular distribution of the alpha particles using a simple "lump" stripping model. Scattering amplitude and differential cross section are calculated from experimental data.

Lindsay, Richard H. and Robert J. Carr
(He^4, Be^7) REACTION IN MAGNESIUM, ALUMINUM, TITANIUM, COBALT, AND COPPER FROM THRESHOLD TO 42 MeV. Physical Review, v. 120, 2168-2174 (Dec. 1960)
Cross sections for the production of Be^7 in the He-ion bombardment of Mg, Al, Ti, Co, and Cu have been measured in the 30-42 MeV energy range. The excitation functions for these reactions are presented. A study of the bulk (0-90°; 90-180°) laboratory angular distributions by the catcher foil technique of the Be^7 nuclei emerging from 2.0 and 1.85 mg/cm^2 magnesium targets and an examination of the approximate range-energy curves for the Be^7 particles in aluminum and magnesium indicates that the reaction proceeds through a compound nucleus. The experimental excitation function for the $Al^{27}(He^4,Be^7)Na^{24}$ reaction is compared with calculations based on the nuclear evaporation model. The cross sections for the production of Na^{24} and Be^7 in the He-ion bombardment of aluminum are contrasted and the difference between the yields leads to an excitation function for the (He^4, He^3He^4) reaction.

Lotgering, J. K., U. Enz, and J. Smit
INFLUENCE OF Co^{2+} IONS ON THE MAGNETIC ANISOTROPY OF FERRIMAGNETIC OXIDES HAVING HEXAGONAL CRYSTAL STRUCTURES. Phillips Research Reports, v. 16, 441-454 (Oct. 1961)

Lowdin, Per-Olov
BAND THEORY, VALENCE BOND AND TIGHT-BINDING CALCULATIONS. Journal of Applied Physics — Supplement, v. 33: 251-280 (January 1962)
Survey of progress in the refinement and combination of the band theory and valence bond method with special attention given to the tight binding approximation, the virial theorem and correlation effects.

Lozhkin, O. V. , N. A. Perfilov, A. A. Rimskii-Korsakov, and J. Fremlin
DISINTEGRATION OF EMULSION NUCLEI BY 930 MeV PROTONS. Soviet Physics — JETP, v. 11: 1001-1009 (November 1960) (Translation-AIP)
Investigation of the phenomenon of the emission of multiply charged particles (fragments) in nuclear disintegrations, for various energies of the incident particles and various atomic numbers of the target nuclei.

McClelland, W. Melville
PHOTOPRODUCTION OF CHARGED PI MESONS FROM NUCLEI. Physical Review, v. 123: 1423-1435 (August 1961)
Be, C, Al, Cu and Pb bombarded at high energies produce charged, high energy pi mesons which are analyzed to determine section as a function of atomic weight, background counting into, absorption coefficient and index of refraction.

MacFarlane, M. and J. B. French
STRIPPING REACTIONS AND THE STRUCTURE OF LIGHT AND INTERMEDIATE NUCLEI. Reviews of Modern Physics, v. 32: 567-691 (July 1960)
Theoretical analysis of reduced widths, stripping and pickup reactions on lp-ds-shell nuclei and information about the mechanism of stripping reactions.

Makaryunas, K. V. and S. V. Starodubtsev
INVESTIGATION OF THE (α,α'), (α,p), AND (α,t) REACTIONS ON LITHIUM NUCLEI. Zhur. Eksptl' i Teoret, Fiz., v. 38: 372-8 (February 1960) (Russian)
The angular distribution of the reaction $Li^7(\alpha,\alpha')Li^{7*}$ (Q = -4.61 MeV) was investigated at 13.2 MeV. The angular distributions of the reactions $Li^7(\alpha,t)Be^8$ (Q = -2.56 MeV), $Li^6(\alpha,p)Be^9$ (Q = -2.13 MeV), and $Li^7(\alpha,p)Be^{10}$ (Q = -2.56 MeV) were determined at 10.15, 11.5, and 13.2 MeV, respectively. The results were derived from direct interaction theories. From an interpretation of the experimental angular distribution of the reaction (α,α') within the framework of Butler's theory it is shown that the parity of the 4.61 MeV level in the Li^7 nucleus is negative and the spin is equal to one of the following four values: (1/2), (3/2), (5/2), or (7/2).

Maradudin, A. A. , P. A. Flinn, and S. Ruby
VELOCITY SHIFT OF THE MOSSBAUER RESONANCE. Physical Review, v. 126: 9-23 (April 1962)
Evaluation of the mean square velocity of Fe-57 dissolved in Be and stainless steel in both the low and high temperature limits. Determination of a value for the isomeric shift fully correct for the second order Doppler shift associated with the vibration of atoms from a determination of the Mossbauer peak position versus temperature.

Miller, D. and R. K. Hobbie
HIGH-ENERGY NEUTRON BEAM OF 45% POLARIZATION. Physical Review, v. 118, no. 5: 1391-6 (June 1960)

A beam of polarized neutrons was produced by allowing the 164 MeV internal proton beam of the Harvard synchrocyclotron to strike a beryllium target. The neutrons produced in the forward direction were then polarized by scattering from carbon at 15°. When neutrons of energy greater than 110 MeV were selected by the detection process, an average beam energy of 124 MeV resulted. An intensity of 2.9×10^5 neutrons/in^2 min through a 2 in. by 6 in. collimator was obtained, with a polarization 0.447 ± 0.020. The shielding techniques are also discussed.

Myachkova, S. A. and V. P. Perelygin
INTERACTION OF 14.1-MeV NEUTRONS WITH Be^9. Soviet Physics, JETP, v. 13: 876-880 (November 1961) (Translation-AIP)

Investigation of the angular and energy distributions of alpha particles and neutrons produced in the (n,2n) reaction for evaluation of the role of individual levels in the excited Be^8 nucleus.

Nefedov, V. B., V. P. Popov, and Yu. S. Yazvitskii
GAMMA RADIATION IN ELASTIC INTERACTION BETWEEN FAST NEUTRONS AND ATOMIC NUCLEI. U. S. S. R. Sovet Ministrov. Glavnoe Upravelenie po Ispol'zovaniyu Atomnoi Energii, Moscow, 1960, 20p. (AEC-tr-4718)

Investigation of the gamma radiation spectra excited by 14 MeV neutrons in Li, Be, C, O, Mg, Al, Fe and Cu.

Nemets, O. F., L. S. Saltykov, and M. V. Sokolov
THE (p,d) REACTION AND INELASTIC SCATTERING OF PROTONS ON Be^9. Soviet Physics JETP, v. 11: 1199-1200 (December 1960)

Angular distributions of protons inelastically scattered by Be^9 nuclei and of deuterons from the Be^9 (p,d) Be^8 reaction were measured for incident proton energies of 6.8 MeV.

Norbeck, Edwin
LITHIUM-INDUCED REACTION YIELDS BELOW 4 MeV. Physical Review, v. 121: 824-827 (February 1961)

Thick-target yields of the following reactions were measured by counting the beta active products: $Li^7(Li^6,2n)C^{11}$, $Be^9(Li^6,2n)N^{13}$, $C^{12}(Li^6,n)F^{17}$, $C^{12}(Li^7,n)F^{18}$, $N^{14}(Li^6,He^5)O^{15}$, $N1^{14}(Li^6,d)F^{18}$, $N^{14}(Li^7,t)F^{18}$, $O^{16}(Li^6,n)Na^{21}$, $O^{16}(Li^6,He^4)F^{18}$, $F^{19}(Li^6,Li^5)F^{20}$, $Na^{23}(Li^6,Li^5)Na^{24}$. The reactions $F^{19}(Li^6,2p)Ne^{23}$ and $Na^{23}(Li^7,Li^6)$ Na^{24} had too small a yield to permit accurate measurement. All of the yield curves show a very rapid but smooth increase of yield with energy. Some general rules are given for estimating the yield to be expected for any positive "Q" Li beam reaction in the energy range under consideration.

Nordberg, M. E., B. Povh, and C. A. Barnes (California Inst. of Tech., Pasadena)
BETA-ALPHA ANGULAR CORRELATIONS IN B^8 AND Li^8. Phys. Rev. Letters, v. 4: 23-5 (January 1960)

A comparison of the β-α angular correlations in the isotopic spin triplet of mass 8(Li^8, Be^8, B^8) is suggested as a test of the conserved vector current theory of β decay. The β-α angular correlations in Li^8 and B^8 were measured and found to differ by about one-fourth that pre-

dicted. The results suggest that the ratio of coincident counts at 180° to the counts at 90° for Li^8 to the ratio for B^8 was 1.02 ± 0.04 compared to the predicted value of 1.15 or 0.85.

Novikov, M. M. and L. N. Tunitskii
VIBRATIONAL CONSTANTS AND DISSOCIATION ENERGY OF THE BeCl MOLECULE. Optics & Spectroscopy, v. 8: 396-399 (June 1960)
The vibrational structure of the bands of the BeCl molecule has been restudied. Thirty new heads of the Q_1-branches of the bands and 43 new heads of the R_1- and R_2-branches have been found. The values of the vibrational constants ω_0 and $\omega_0 x_0$ in the upper and lower states have been made more precise, and the second anharmonicity coefficients $\omega_0 y_0$ have been determined for the $A^2\Pi$ and $X^2\Sigma$ states. The value of the third anharmonicity coefficient for the $X^2\Sigma$ state has been estimated. A nonlinear extrapolation has been carried out and a new most probable value for the dissociation energy of the BeCl molecule is given: 5.9 ± 0.5 eV. In the 2620 A region, new bands have been discovered, which apparently are to be ascribed to a transition from a new, higher electronic state of the BeCl molecule.

Notarrigo, S., R. Parisi, R. Ricamo, and A. Rubbino
NEUTRONS FROM Po-Be SOURCES. Nuclear Physics, v. 29: 507-514 (January 1962)
One curie of Po is mixed with powdered Be and placed in a Pt cylinder and the neutron emission is found to be 2.8×10^6 per sec. The neutrons are detected by means of proton recoil tracks in emulsion plates and the neutron energy spectrum is determined and found to agree well with the calculated.

Parkinson, D.
ATOMIC POLARIZABILITIES. Proc. Phys. Soc. v. 75, Pt. 2: 169-73 (February 1960)
An antisymmetrical Hartree approximation is applied to the calculation of the polarizabilities of lithium and beryllium and of various ions iso-electronic with atoms of the second row of the periodic table. The results are in harmony with the available experimental data.

Pilyankevich, A. N.
CALCULATION OF INELASTIC SCATTERING FOR ELECTRONS OF INTERMEDIATE ENERGY. Soviet Physics, Technical Physics, v. 6: 161-165 (August 1961) (Translation-AIP)
To describe physical processes involved in electron microscopes, the scattering characteristics of electrons on the target material must be accounted for. Problems related to inelastic scattering of electrons on isolated atoms are considered. Scattering forces and cross sections are calculated for electrons of intermediate energy and the inelastic scattering cross sections are calculated for scattered electrons of Li, Be and Na.

Pomerantz, M. and T. P. Das (California U., Berkeley)
THEORY OF NUCLEAR QUADRUPOLE INTERACTION IN BERYLLIUM METAL. Physical Review, v. 119: 70-78 (July 1960) (Also issued as AD-247998)
The theory of the origin of the field gradient at nuclei in metals has been analyzed. The contributions of the ion cores and conduction electrons have been separately considered. In the case of beryllium

metal, using orthogonalized plane wave functions, the conduction electrons are shown to enhance, by about eight percent, the field gradient due to the ion cores. Combining the results of our calculations with Knight's experimental value of 48 kc/sec for the Be(9) coupling constant e(to the second power)qQ/h, a value of 0.032 times 10(to the -24 power) sq cm for Q is obtained. The dependence of the potential for the conduction electrons on the model chosen is analyzed in some detail. The various uncertainties in our field-gradient calculation and the theoretical value of the Knight shift in beryllium metal are discussed.

Popova, V. M., N. G. Semashko, and F. R. Yagudina
PHOTOPRODUCTION OF LOW-ENERGY CHARGED PIONS FROM COMPLEX NUCLEI. Zh. eksper. teor. Fiz., v. 36, no. 5: 1357-9 (May 1959) (Russian) English translation in: Soviet Physics — JETP v. 36(9), no. 5: 965-6 (November 1959)

The yields of charged photomesons with energies from 0 to 3 MeV at an angle of 90° to a photon beam were investigated for Be, C, Al and Cu nuclei. The maximum photon energy was 265 MeV. The dependence on the negative π-meson yield and the ratio of the positive versus negative π yield on the atomic number were found. Comparison of the experimental data with the physical calculations of Baldin and Lebedev (Abstr. 6166 of 1958) gave the result that the mesons are formed from the nucleons on the nuclear surface.

Powell, C. J.
THE ORIGIN OF THE CHARACTERISTIC ELECTRON ENERGY LOSSES IN TEN ELEMENTS. Proceedings of the Physical Society, v. 76: 593-610 (November 1960)

Measurements have been made of the characteristic electron energy loss spectra of beryllium, antimony, bismuth, germanium, tin, cadmium, copper, platinum, lead and calcium using the reflection technique and with 750 eV and 1500 eV primary electrons. The spectra of each element were found to consist almost entirely of combinations of two fundamental energy losses which were identified as plasma and lowered plasma losses. A striking correlation between the lowered plasma losses and the corresponding calculated values of $\hbar\omega_p/\sqrt{2}$ was observed (ω_p is the plasma frequency), and it is suggested that the magnitude of the lowered plasma loss may be useful as an indication of the effective free electron density. If the specimen oxidized appreciably, the intensity of the lowered plasma loss decreased rapidly and a new modified lowered plasma loss appeared. It is considered that the present results are characteristic of clean metal surfaces and that many of the discrepancies in past work can be explained by the presence of surface contaminants.

Powers, D. and W. Whaling
RANGE OF HEAVY IONS IN SOLIDS. Physical Review, v. 126: 61-69 (April 1962)

Measurements of the ranges of N, Ne, Ar, Kr and Xe ions are Be, C, B and Al for incident ion energy 50-500 Kw. A monoenergetic ion beam from an electrostatic accelerator strikes a thick target of the absorber and the penetration depth is determined by a momentum analysis of monoenergetic protons elastically scattered from the target.

Pretis, M. de and G. Poiani (Università, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy)

SOME RESULTS CONCERNING HEAVY UNSTABLE NUCLEAR FRAGMENTS EJECTED FROM INTERACTION OF 4.5 GeV π^- IN EMULSION. Nuovo cimento (10), v. 15, Suppl. no. 3: 265-81 (1960) (English)

Results are given from an investigation of a stack of 600 μm Ilford G-5 emulsions, exposed to 4.5-BeV π^- mesons. The nature, emission spectra, and angular distributions of unstable nuclear fragments and hyperfragments produced in the emulsions were studied. The ejected fragments selected for characterization studies were Li^8, Li^9, Be^8, B^8, B^{12}, and C^{12}. The modes of decay and excited levels are outlined for these fragments. Data on 29 hyperfragments identified with certainty are reported. Their angular and energy distribution does not support the view that their mechanism of production is substantially different from that of unstable fragments of nonhyperonic origin.

Propin, R. Kh.

CALCULATION OF THE PROBABILITY OF AUTOIONIZATION IN He^- AND Be^+ IONS. Optics and Spectroscopy, v. 10: 155-157 (March 1961)

The probability of autoionization of He^- and Be^+ ions is calculated in terms of energy states and their wave functions.

Purohit, S. N.

TIME-DEPENDENT THERMAL NEUTRON ENERGY SPECTRA IN A MONATOMIC HEAVY GAS. Nuclear Science and Engineering, v. 9: 305-313 (March 1961)

Time-dependent energy spectra generated in a monatomic heavy gas with the help of a multigroup formalism are obtained for the finite and infinite media of Be and graphite. Spectra behavior in the last stage of neutron thermalization and diffusion periods are noted, with data given for thermalization times and diffusion cooling coefficients.

Reiss, H., S. W. Mayer, and J. L. Katz

LAW OF CORRESPONDING STATES FOR FUSED SALTS. Journal of Chemical Physics, v. 35: 820-826 (September 1961)

Development of reduced equations of state and laws of vapor pressures, surface tensions and melting points for strictly ionic salts of MgO, CaO, SrO, BaO, NaF, NaCl, NaBr, NaI, KF, KCl, KBr, KI, RbF, RbCl, RbBr, RbI, CaF, CsCl, CsBr, CsI, LiF, LiCl, LiBi and LiI through analysis of the configuration integral. State vapor pressure data are included for all divalent halides.

Ritter, Z. W., R. Pauncz, and K. Appel

APPROXIMATE ANALYTICAL WAVE FUNCTIONS FOR THE $1s^2ns$, $^2S_{1/2}$ STATES OF Li AND Li-LIKE IONS. Journal of Chemical Physics, v. 35: 571-575 (August 1961)

Calculation of wave functions of Li and Li-like ions, including Be, B, C, N, O and F, allowing for radial correlation in the inner shell structure. Angular correlation is discussed as a factor in the ground-state energy values.

Robins, J. L.

CHARACTERISTIC ELECTRON ENERGY LOSS SPECTRA OF A NUMBER OF SOLID ELEMENTS. Physical Society, Proceedings, v. 79: 119-132 (January 1962)

Determination of the characteristic electron energy loss spectra for Ga, In, Tl, As, Se, Te, Be, Na, Mg, Al, K, Ca, Ti, V, Cr, Mn,

Fe, Co, Ni, Cu, Zn, Ge, Zr, Pd, Ag, Cd, Sn, Sb, Bi, Pb, Au, Pt and Ba using the reflection technique and primary electron energies of 800 and 1500 eV.

Roothaan, C. C. J. (Argonne National Lab., Ill.); Lester M. Sachs (Argonne National Lab., Ill. and Illinois Inst. of Tech., Chicago); and A. W. Weiss (Univ. of Chicago)

ANALYTICAL SELF-CONSISTENT FIELD FUNCTIONS FOR THE ATOMIC CONFIGURATIONS $1s^2$, $1s^22s$, AND $1s^22s^2$. Revs. Modern Phys., v. 32: 186-94 (April 1960)

A generalized self-consistent field (SCF) function formalism is given for the atomic configurations $1s^2$, $1s^22s$, and $1s^22s^2$ for atoms and ions up to Z = 10. The treatment is similar to that of Nesbet except for the approximations involved in the Lagrangian multipliers coupling the inner and outer shells. Results are given for Li ions and Be, and the SCF orbitals are stated to be equivalent to solutions of the integro-differential Hartree-Fock equations to 4 decimal places.

Saji, Yoshio (Univ. of Tokyo)

ENERGY SPECTRUM AND ANGULAR DISTRIBUTIONS OF NEUTRONS FROM THE REACTION $Be^9(p,n)B^9$ AT 8 TO 14 MeV OF PROTON ENERGIES. J. Phys. Soc. Japan, v. 15: 367-71 (March 1960)

The $Be^9(p,n)B^9$ reaction has been studied by using a fast neutron spectrometer with a hydrogen gas radiator. The energy spectrum of neutrons from the reaction at 14.1 MeV was obtained and three new excited levels (3.07, 4.14, and 4.94 MeV) in B^9 were observed. They are consistent with the levels of the mirror nucleus, Be^9, and the level scheme of intermediate coupling model introduced by Kurath. The angular distributions of the neutrons at 8.1 to 14.1 MeV were obtained. The results do not agree with the theory of Austern, Butler, and McManus. The isotropic parts of the neutron angular distributions become larger as the incident proton energies decrease, probably due to the fact that in the lower energy region compound nucleus formation is more preferable.

Sakamoto, Yoshiyuki and Toshinori Takemiya (Kyoto Univ.)

POLARIZATION OF PROTON SCATTERED FROM Li^6, Be^9 AND B^{11}. Progr. Theoret. Phys. (Kyoto), v. 23: 172-5 (January 1960) (English)

Expressions for the polarization of protons elastically scattered by Be^9, B^{11}, and Li^6 are derived using spin wave functions and are composed of two terms, that for the spin flip and that for the non-spin flip of target nucleons. Since the non-spin flip is dominant in the polarization, the results for Be^9, B^{11}, and Li^6 are very similar. Graphs are presented with experimental and theoretical curves for 180-MeV protons.

Shklyarevskii, I. N. and R. G. Yarovaya

OPTICAL PROPERTIES OF BERYLLIUM IN THE INFRARED SPECTRAL REGION. Optics and Spectroscopy, v. 11: 355-357 (November-December 1961)

Measurement of the optical constants, Hall constant and the static conductivity of vacuum deposited Be layers at 82-290°K. Determination of the concentration, effective mass and frequency of collision among carrier particles. Using the formulas of the normal skin effect and taking account of the quantum character of the interaction of free carriers with infrared radiation.

Spear, R. H.
THE ENERGY SPECTRUM OF PROTONS FROM THE $^7Be(d,p)^8Be$ REACTION. Austral. J. Phys., Vol. 12, No. 1: 99-102 (March 1959)
An angular distribution camera was used to analyze the protons from the reaction $Be^7(d,p)Be^8$. Since this reaction has high Q-values, foils were used to eliminate lower energy protons from contaminant reactions. At three angles of observation the energy of the excited state observed was therefore estimated from that of the protons corresponding to the ground state of Be^8 whose Q-value was calculable. By combining the results of the three angles, a level in Be^8 with an excitation energy of 2.9 MeV was confirmed.

Spencer, R. R. and J. R. Smith
COMPETITIVE EXTINCTION IN NEUTRON MONOCHROMATING CRYSTALS. Nuclear Science and Engineering, v. 8: 393-399 (November 1960)
Analysis of anomalies observed in the Bragg beam produced by Be $(10\bar{1}1)$, Be $(10\bar{1}3)$, Be $(10\bar{1}0)$ and Be (0002) monochromators on the MTR crystal spectrometer. Instead of a smooth spectrum characteristic of a Maxwellian distribution of neutron velocities, many large dips are found. Spectra produced by the (200), (220) and (240) planes of NaCl are examined to establish that these anomalies are due to crystal properties.

Stanton, H. E.
ON THE YIELD AND ENERGY DISTRIBUTION OF SECONDARY POSITIVE IONS FROM METAL SURFACES. J. appl. Phys., v. 31, no. 4: 678-83 (April 1960)
The kinetic energy distribution of secondary positive ions liberated from a solid metallic target of beryllium under bombardment by positive ions was measured in a mass spectrometer provided with an energy analyser. In conformity with earlier investigations, it was found that an appreciable fraction of the ions was liberated with energies less than 5-10 eV, although some secondary ions of more than 200 eV were found. The distributions appeared to be at least partially Maxwellian in character. Although errors in measurement were large, there appeared to be little dependence of the yield of secondary ions on the mass of the bombarding ion.

Stanton, R. E.
HELLMANN-FEYNMAN THEOREM AND CORRELATION ENERGIES. Journal of Chemical Physics, v. 36: 1298-1300 (March 1962)
A proof of the applicability of the Hallmann-Feynman theorem to Hartree-Fock wave functions is presented, with applications to atomic correlation energies and molecular dissociation energies for H^-, He, Li^+, Be^{2+}, B^{3+}, C^{4+}, Be, F^- and Al^{3+}.

Starodubtsev, S. V. and K. V. Makarunas
DIRECT INTERACTION MECHANISM IN THE $Li^6(\alpha,d)Be^8$ REACTION. Doklady Akad. Nauk S.S.S.R., v. 129: 547-9 (November 1959) (Russian)
Natural lithium was bombarded by 8.34- to 13.2 MeV α particles. The emitted secondary particles were recorded on photoplates (of 100μ thickness) distributed in the scattering chamber. The mean angle between the photoplates and particle motion from the target was 10°. An intense group of deuterons from the reaction $Li^6(\alpha,d)Be^8$, Q = 1.59 was detected. The angular distributions in the center of inertia system are

plotted for α bombardment at 10.15, 11.5, and 13.2 MeV. The absolute magnitude of the differential cross section with E_α = 10.15 MeV at 58° is equal to 6.7 mb/steradian. The integral cross section, derived by angular distribution, at E_α = 10.15 is not less than 50 mb. The cross section diminishes with an energy increase from 10.15 to 13.2 MeV. The deuteron angular distribution indicates the presence of deuteron substructure in Li^6.

Staub, Hans H. and Hubert Winkler (Universität, Zurich)
ABSOLUTE DETERMINATION OF THE THRESHOLD VALUE OF THE REACTION $Li^7(p,n)Be^7$. Nuclear Phys., v. 17: 271-8 (June 1960) (German)

The threshold proton energy of the reaction $Li^7(p,n)Be^7$ is measured using the magnetic deflection technique in a homogeneous 180° field. The procedure of extrapolation of the yield curve is presented. The final value obtained is 1880.3 ± 0.5 keV. A summary of all recent values of this threshold energy is presented. Revised values of resonance energies measured by Bumiller et al. are given as the present measurements allow an accurate correction for the permeability of the vacuum chamber.

Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.)
RANGE-ENERGY RELATIONS FOR PROTONS IN Be, C, Al, Cu, Pb, AND AIR. Phys. Rev., v. 115: 137-42 (July 1959)

Range-energy relations for protons were obtained for six substances; Be, C, Al, Cu, Pb, and air. The calculations of the energy loss dE/dx include the shell corrections at low energies and the density effect which becomes important in the high-energy region. The present results can also be used to determine the range of μ mesons up to ~10 BeV. Besides the calculated values of the ranges, tables of the ionization loss dE/dx are also presented.

Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.)
RANGE STRAGGLING OF CHARGED PARTICLES IN Be, C, Al, Cu, Pb, AND AIR. Phys. Rev., v. 117: 485-8 (January 1960)

The straggling of the range of charged particles due to fluctuations of the ionization loss was evaluated for six substances (Be, C, Al, Cu, Pb, and air). The calculations extend up to $T/\mu c^2 \sim 100$, where T is the kinetic energy and μ is the mass of the incident particle. At high energies ($T/\mu c^2 \gtrsim 5$), the integral giving the range straggling becomes somewhat dependent on the ratio μ/m, where m is the electron mass. Two separate calculations were carried out, which apply to protons and μ mesons, respectively. The results for protons can be used for π and K mesons in the energy range of interest ($T/\mu c^2 \lesssim 5$).

Strukov, B. A., N. D. Gavrilyuk, and V. A. Koptsik
SOME ASPECTS OF THE FERROELECTRIC PHASE TRANSITION IN $(NH_4)_2 BeF_4$. Soviet Physics — Crystallography, v. 6: 625-627 (March-April 1962) (Translation-AIP)

Measurement of the Curie point as a function of field and the spontaneous polarization, dielectric constant and thermal capacity as functions of temperature in a dry air atmosphere. Circuit measurements of loss angle, coercive field and electromechanical coupling constant.

Swartz, Clifford E. and Paul Feldman
BERYLLIUM FOIL MONITOR FOR EXTERNAL PROTON BEAM. Review of Scientific Instruments, v. 33: 565-566 (May 1962)
A new instrument for monitoring high energy proton beams at the cosmotron consisting of 98.5% Be target material which is irradiated by an external proton beam.

Talmi, I. and I. Unna (The Weizmann Inst. of Science, Rehovoth, Israel)
ORDER OF LEVELS IN THE SHELL MODEL AND SPIN OF Be^{11}. Phys. Rev. Letters, v. 4: 469-70 (May 1960)
The ground-state spin of Be^{11} is discussed in view of the proton configuration dependence of the order of filling neutron shells. Experimental data recently obtained indicate a spin and parity of 1/2 +. It is shown that a 1/2 + spin of Be^{11} due to a $2s_{1/2}$ neutron is plausible and even preferred on the basis of the detailed quantitative scheme of the shell model. The competition between the $s_{1/2}$ and $p_{1/2}$ levels for B^{11}, B^{12}, and C^{13} and the $d_{5/2}$ and $s_{1/2}$ levels for C^{15}, N^{16}, and O^{17} are given. The spin levels in Be^{11} and C^{15} resulted from linear extrapolations of the spin levels in the remaining isotopes for each group and other data.

Tombrello, T. A. and G. C. Phillips
CLUSTER NATURE OF Li^7 AND Be^7. Physical Review, v. 122: 224-228 (April 1961)
Measurements of the capture gamma radiation processes give information about the cluster structure of the mirror nuclei Li^7 and Be^7. The cluster model predicts that the ground state and low excited states of these nuclei should have large reduced widths for the configuration mass 3 plus alpha particle and small reduced widths for the configuration nucleon plus Li^6. Scattering experiments provide accurate initial capturing wave functions and an assumption of the cluster nature of the final bound states, and allows the electromagnetic capture cross sections to be calculated.

Vashakidze, I. Sh., T. I. Kopaleyshvili, V. I. Mamasakhlisov, and G. A. Chilashvili
ON THE STRUCTURE OF THE Be^9 NUCLEUS. Zhur. Eksptl'. i Teoret. Fiz., v. 38: 937-41 (March 1960) (Russian)
For the Be^9 nucleus viewed as consisting of two α-particles and a neutron the equilibrium distances between the α-particles and between the neutron and centers of the α-particles were determined from the condition of minimum energy. Vibrations along the symmetry axis and about the center of mass of the α-particles were considered and the energy levels of the Be^9 nucleus were derived. The results obtained are compared with data relating to the $_{\Lambda}Be^9$ hypernucleus.

Viryasov, N. M., A. S. Vovenko, G. G. Vorobev, A. D. Kirillov, Hu-ying Kim, B. A. Kulakov, A. L. Lyubimov, Yu. A. Matulenko, I. A. Savin, E. V. Smirnov, L. N. Strunov, and I. V. Chuvilo
2.8 BeV/c MOMENTUM ANTIPROTON CHANNEL. Zhur. Eksptl'. i Teoret. Fiz., v. 38: 445-8 (February 1960) (Russian)
The separation of antiprotons possessing a momentum of 2.8 BeV/c is described. Data on the relative frequency of generation of antiprotons and π-mesons in Be and Cu were determined.

Vlasov, N. A., S. P. Kalinin, A. A. Ogloblin, V. I. Chuev
THE REACTION B^{11} (d,t) B^{10}. Soviet Physics: Journal of Experimental and Theoretical Physics, v. 12: 1129-1130 (June 1961)

Reaction is studied for 20 MeV deuterons. In accordance with the level scheme of the B-10 nucleus, excitation of the lower levels of B^{10} occurs as a result of ejection of a neutron. Probability of the ground state is several times higher than that of the excited states. Reduced widths from the reactions B^{11} (d,t) B^{10} and Be^{9} (d,n) B^{10} are compared.

Vlasov, N. A. and A. A. Ogloblin
(d,t) REACTIONS ON Li^{6}, Li^{7} AND Be^{9} NUCLEI. Zh. eksper. teor. Fiz., v. 37, no. 1(7): 54-61 (July 1959) (Russian) English translation in: Soviet Physics — JETP, v. 37(10), no. 1: 39-44 (January 1960)

The spectra of tritons emitted at various angles in these reactions were studied for 20 MeV deuterons. The probability of formation of excited states in the final nucleus decreases sharply with increasing excitation energy. Angular distributions were obtained for triton groups corresponding to the formation of Li^{5} in the ground state, Li^{6} in the ground and in the first two excited states, and Be^{8} in the ground and in the first excited state. The angular distributions are in good agreement with those computed from the Butler formula for (d,t) reactions, but the radius increases with the level energy.

Vratny, F., M. Dilling, F. Gugliotta, and C. N. R. Rao
INFRARED SPECTRA OF METALLIC OXIDES, PHOSPHATES AND CHROMATES. Journal of Scientific & Industrial Research, v. 20B: 590-593 (December 1961)

Absorption maxima is determined for 51 oxides and oxide like materials using a Perkin-Elmer double-beam spectrometer. Indication of the correlation and the sensitivity of the technique to changes in the electronic character of the oxides.

Wegner, H. E. and W. S. Hall (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico)
STUDY OF (He^{3},d) AND (He^{3},t) REACTIONS IN LIGHT NUCLEI AT 25 MeV. Physical Review, v. 119, no. 5: 1654-1665 (September 1960)

Angular distributions for the Be^{9} (He^{3},d) B^{10}, Be^{9} (He^{3},t) Be^{9}, C^{12} (He^{3},d) N^{13}, and Ca^{40} (He^{3},d) Sc^{41} reactions were measured at 25 MeV and also at 21 MeV for the carbon reaction. It was found that the angular distributions were strongly peaked forward, exhibited diffraction-like structure, and were asymmetric about 90°. The minimal positions of the angular distributions could be fitted with spherical Bessel functions of the appropriate order l, the angular momentum transfer of the ingoing proton. This analysis resulted in the same interaction radius for various levels in each of these reactions. The best fit interaction radius for each case was 6.17, 5.91, 6.23, and 7.29 fermis, respectively. The Butler stripping theory was also fitted to the angular distributions; however, the average decrease of the angular distributions did not agree with the predicted decrease except in one case. The reactions exhibited the general characteristics of a direct process and could be predicted qualitatively with the simple form of direct interaction theories. The experimental equipment and the method of data anlysis, using computer codes, is described. The ground-state Q values were measured for the Ca^{40} (He^{3},d) Sc^{41}, Ca^{40} (d,n) Sc^{41}, and O^{16} (He^{3},d) F^{17} reactions. Q values for levels excited by the Ca^{40} (He^{3},d) Sc^{41} reaction were also measured.

Weidenmüller, J. A.
POSSIBILITY OF A TEST OF THE CONSERVED VECTOR CURRENT THEORY IN THE A = 8 POLYAD. Phys. Rev. Letters, v. 4, no. 6: 299-302 (March 1960)

The M1 and E2 amplitudes for the transition from the lowest J = 2, T = 1 level in B^8 to the first excited state. J = 2, T = 0, of Be^8 are evaluated by an intermediate coupling calculation, limits being placed on the free parameters by fitting the magnetic moment of Li^8 and the beta decay rate. These values are then used to place limits on the B-α angular correlation in the decay of B^8, for both the conserved vector current theory of beta decay and the original Fermi theory. The results, when compared with experiment, slightly favour the Fermi theory but, owing mainly to the possible error in the evaluation of the E2 rate, this cannot be regarded as conclusive evidence.

Weston, L. W. and W. S. Lyon
NEUTRON CAPTURE CROSS SECTION OF Au AT 30 keV AND 64 keV. Physical Review, v. 123: 948-949 (August 1961)

Kinematically collimated neutrons from the Li^7 (proton, neutron), He^3 and T (proton, neutron), He^3 reactions are used to measure the capture cross section at 30.2-keV and 6.39-keV.

Wiedenbeck, M.
TOTAL X-RAY ATTENUATION COEFFICIENTS FROM 40-412 keV. Physical Review, v. 126: 1009-1010 (May 1962)

Measurement of the attenuation coefficients at 40-412 keV for Be, C, Al, Fe, Co, Ni, Cu, C, Mo, Ag, Cd, In, Sn, Ta, W, Pt, Au, Pb and Tb.

Wilmshurst, J. K.
ORBITAL RADII AND THE DEPENDENCE OF BOND LENGTH UPON IONICITY, HYBRIDIZATION, AND BOND ORDER. Journal of Chemical Physics, v. 33: 813-820 (September 1960)

Expressions for the dependence of hybrid orbital radii upon the constituent atomic orbitals and the ionicity of the bond to be formed are given. Using accurate bond-length data (± 0.005A) and a suitable expression for bond ionicity, atomic orbital radii have been obtained for the elements of the first four periods (other than transition metals). These radii can be used to calculate bond lengths in lone molecules, ionic crystals or metals or, alternatively, the experimental internuclear distance can be used in the same manner as the nuclear quadrupole coupling constant to describe the bond parameters in some detail.

Wittern, Hans (Universität, Munich)
THE INTERPRETATION OF α-α SCATTERING. Naturwissenschaften, v. 46: 443-4 (1959) (German)

A semiphenomenological potential is derived from a consideration of the repulsion of single nucleons given by the Pauli principle and from the character of the shell model wave functions for the actual levels of the Be^8 compound nucleus and their excitation functions. The scattering phases are calculated from the potential.

Wright, Kenneth A. and John G. Trump
BACKSCATTERING OF MEGAVOLT ELECTRONS FROM THICK TARGETS. Journal of Applied Physics, v. 33: 687-690 (February 1962)

Measurements of the number and energy of the electrons which rebound from U, Be, Al, Cu and Pb bombarded at normal incidence by

monoenergetic electrons at 1-3 MeV. Measurement of the secondary electron emission and the backscattered electron current in vacuum.

Zaika, N. I. and O. F. Nemetz (Inst. of Physics. Academy of Sciences Ukrainian, SSR)

ANGULAR DISTRIBUTION OF PROTONS IN REACTIONS Be^9 (d,p) Be^{10}, Si^{28} (d,p) Si^{29}, AND Bi^{209} (d,p) Bi^{210}. Izvest. Akad. Nauk. S. S. S. R., Ser. Fiz., v. 23: 1460-4 (December 1959) (Russian)

A spectrometer, based on the ionization chamber principle, was developed for measuring proton spectra. The angular distributions of protons corresponding to the excited states of Be^{10} and Si^{29} and the ground state of Bi^{210} are plotted. The silicon and bismuth radii were calculated using the formula $r_0 = (1.7 + 1.22\ A^{1/3}) \times 10^{-13}$ cm, while for beryllium a better result is obtained with the radius equal to 4.8×10^{-13} cm, which is somewhat higher than that obtained by the formula. The spin 0^+ is assigned to the ground state of B^{10} and 1^+, 2^+, or 3^+ to the excited states. The ground state spin of Si^{28} is 0^+ and for Si^{29} has spins $(3/2)^+$ and $(5/2)^+$. The angular distributions from the second, third, and fourth levels were not found due to low proton intensities of the respective groups. Possible spins for the fifth level are $(5/2)^-$ and $(7/2)^-$; and 3.62 MeV the shell model assigns the value $(1/2)^+$. Two characteristic proton maxima are found at 50 and 85° angles from Bi^{209} (d,p) reactions with 14 to 15 MeV deuterons.

Reactor Core Materials, v. 3: 30-47 (November 1960)

CLADDING AND STRUCTURAL MATERIALS.

"...metallurgical aspects of Al and Ag alloys, ...Be..."

AD-243716

Cornell U., Ithaca, N. Y.

ABSORPTION OF SOFT X-RAY PHOTONS BY ELECTRONS IN METALS. FINAL REPORT SEPTEMBER 16, 1959-SEPTEMBER 15, 1960. D. H. Tomboulian. 4p. incl. table. (OOR Rept. no. 2486:4) (Contract DA 30-069-ORD-2746, OOR Proj. 2486)

Investigation involved the examination of the following metals: beryllium, magnesium, aluminum, nickel, and copper and to a less extent manganese and cobalt. The choice of the metals listed was dictated by the availability of reliable electron energy loss and x-ray fine structure data. The technical difficulties involved in the preparation of samples was also a consideration. The values of maxima in the absorption curve involving the attenuation of photons by valence electrons are listed. The incident photon energies are expressed in electron volts.

AD-251723

Catholic U. of America, Washington, D. C.

AN LCAO STUDY OF Be_2. Robert Hampson and J. S. Dooling. 1960. 28p. incl. illus. tables, 11 refs. (AFOSR TN 60-91) (Contract AF 18(600)1537)

These calculations were made to study the interaction of two Be atoms as related to crystal formation. The effect of including 2p Sigma atomic orbitals in the calculation was studied. An excited state calculation was made to see whether this state would exhibit binding.

AD-251868

American Meteorological Society, Boston, Mass.
THE THREE-CONFIGURATION APPROXIMATION FOR BERYLLIUM TYPE ATOMS. (Trekhkonfiguratsionnoe Priblizhenie v Sluchae Atomov Tipa Berilliia). I. V. Batarunas, V. I. Kavetskis, and A. P. Iutsis. Translated by Valys Zilius. July 1960. 9p. incl. tables. (Trans no. T-R-309 from Akademiia Nauk Litovskoi SSR, Trudy, Ser. B., v. 3: 9-16 (1955)) (Contract AF 19(604)6113)

The concept of two-electron states is introduced. It is shown that the transition from a one-configuration approximation to a many-configuration approximation can, for all intents and purposes, be considered a transition from the model of one-electron states to an approximation of the model of two-electron states. The three-configuration approximation is applied to the basic configuration Be, B^+ and C^{++} using a method by which, in the case of the investigated configuration, one-electron wave functions of the self-consistent Fock field were used, and in the case of the computed configurations, analytical hydrogen-like functions. For comparison we give, in the cases Be and B(+), the results of the application of such an approximation using wave functions which are solutions of simplified Fock equations for individual two-configuration approximations. The theoretical energy values are compared with experimental data. We show the possibility of developing an empirical method for deriving approximate wave functions in a multi-configuration approximation.

AD-264825

Metals and Ceramics Lab., Wright Patterson Air Force Base, Ohio
ELEVATED TEMPERATURE SYNAMIC ELASTIC MODULI OF VARIOUS METALLIC MATERIALS. REPORT FOR AUGUST 1959-JULY 1960 ON METALLIC MATERIALS. W. H. Hill and K. D. Shimmin. March 1961. 75p. (WADD TR 60-438) (Proj. no. 7351)

AD-270957

Institute for Molecular Physics, U. of Maryland, College Park
POTENTIAL CURVES FOR BeH(+) AND CH(+). Shirley M. Read, Joseph T. Vanderslice and Frantisek Jenc. December 1961. 6p. (Technical rept. no. 4) (Contract Nonr-59514; In cooperation with Institute of Organic Chemistry and Biochemistry, Czechozlovakian Academy of Science, Praha, Czechozlovakia)

Determination of potential curves for the positive monovalent BeH and CH ions, using the Rydberg-Klein-Rees method for deriving potentials from spectroscopic data.

AD-271409

Palmer Physical Lab., Princeton U., N. J.
PARTICLE PRODUCTION AT LARGE ANGLES BY 10-33 BeV PROTONS INCIDENT ON ALUMINUM AND BERYLLIUM. V. L. Fitch, S. L. Meyer, and P. A. Piroue. January 1962. 4p. (Technical rept. no. 29) (Contract Nonr-185806; In cooperation with Naval Ordnance Lab.)

Mass of particles emitted from Al and Be targets is determined from momentum and velocity, using the magnetic deflection and time-of-flight technique.

ANL-6122 (p. 163-76)

Oak Ridge National Lab., Tenn.
THE FAST MULTIPLICATION EFFECT DUE TO THE (n,2n) REACTION IN BERYLLIUM AND BERYLLIUM OXIDES. Wolf Häfele. p. 163-76 of PROCEEDINGS OF THE CONFERENCE ON THE PHYSICS OF BREEDING, OCTOBER 19-21, 1959.

Upper and lower limits were established for the fast multiplication effect in Be and BeO due to the (n,2n) reaction. Nonisotropic scattering was taken into account.

APEX-633

General Electric Co. Flight Propulsion Lab. Dept., Cincinnati
EVALUATION OF BERYLLIUM AND URANIUM CROSS SECTIONS FOR NEUTRON DIFFUSION THEORY CALCULATIONS. F. G. Dawson. October 1958. 38p. (Contracts AF 33(600)-38062 and AT(11-1)-171)

APEX-653

ASTRA, Inc., Raleigh, N. C.
HAND CALCULATION OF SPATIAL DISTRIBUTION OF NEUTRON ACTIVATION. J. T. Lence, H. R. Kroeger, Andrew Lowery, F. A. Bryan, Jr., and E. M. Page. August 1960. 34p. (Contracts AF 33(600)-38062 and AT(11-1)-171)

Development of methods of calculation of the foil activation distributions for sulphur and bare and Cd-coated Cu, in BeO, LiH and stainless steel shielding materials.

ASD-TR-61-147

Honeywell Research Center, Hopkins, Minn.
NORMAL SPECTRAL REFLECTANCE OF ANODIZED COATINGS ON ALUMINUM, MAGNESIUM, TITANIUM AND BERYLLIUM. J. E. Janssen, R. H. Torborg, J. R. Luck, and R. N. Schmidt. June 1961. 289p. (Contract AF 33(616)-6191)

Normal spectral reflectance measurements for anodized specimens of Al, Mg, Ti and Be in vacuum at 100-1300°F. Determination of the ratio of solar absorbance to infrared emittance for Al anodized in H_2SO_4 and A110AT Ti anodized in NaOH.

AWRE-0-27/60

United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England
NEUTRON CROSS-SECTIONS OF BERYLLIUM IN THE ENERGY RANGE OF 0.025 eV-15 MeV. K. Parker. September 1960. 38p.

Possible reactions of neutrons with beryllium are discussed for energies up to 15 MeV. Tables of data were compiled for elastic, inelastic, and total cross sections, and for angular and energy distributions of beryllium at 0.025 eV to 15 MeV.

BNL-607

Brookhaven National Lab., Upton, N. Y.
NEUTRON CROSS SECTION EVALUATION GROUP NEWSLETTER NO. 1, JUNE 1960. Rudolph Sher and Sophie Moore. 8p.

The discrepancy in the $Be^9(n,2n)$ cross section as measured by Fischer and Levin & Cranberg was partially resolved in the 2.6- to 4.1-MeV region by new measurements of the nonelastic neutron scattering. The cross section for differential elastic neutron scattering for Be^9 was determined at 2.6 to 6.0 MeV, together with that for $Be^9(n,\alpha)$ at 3.9 to

8.6 MeV. B^{10} was determined to be present in natural B to the extent of 19.8 ± 0.1%, and the cross sections for $B^{10}(n,\alpha)$ and natural B (absorption) were found to be 3840 ± 10 and 762 ± 3 barns, respectively. The cross sections for $B^{10}(n,\alpha)$ and $B^{10}(n,2\alpha)$ were determined in the MeV range. Cross sections are reported for $O^{16}(n,\alpha)$ at 5 to 7.34 MeV, O^{16} differential elastic neutron scattering at 3.0 and 6.0 MeV, $Ar^{36}(n,\alpha)$ at 1.3 to 5.5 MeV, and $Ar^{40}(n,\alpha)$ at 5.75 to 8.94 MeV. Neutron capture cross sections in the keV energy range are reported for Nb, Mo, Rb, Pd, Ag, Cd, In, Sn, W, Pt, and Au. Thermal neutron total cross sections at 0.02 to 0.20 eV are reported for U^{233}, U^{235}, Pu^{240}, U^{234}, and I^{129}, with the results for 0.02 to 0.04 eV being given at 2200 m/sec. Neutron multiplication data are given for U^{233} and Pu^{239}.

CERN-61-1

European Organization for Nuclear Research, Geneva
HIGH-ENERGY NUCLEAR REACTION CROSS-SECTIONS. E. Bruninx. January 1961. 107p.

A compilation is presented of formation cross sections in the region beryllium to copper for nuclear reactions above 50 MeV.

CU(PNPL)-202

Columbia Univ., New York. Pegram Nuclear Physics Labs.
PROGRESS REPORT FOR OCTOBER, NOVEMBER, DECEMBER 1959 TO THE UNITED STATES ATOMIC ENERGY COMMISSION. 39p. (Contract AT-30-GEN-72.

The Nevis cyclotron was shut down, but work proceeded on instrumental improvements and data analysis. Analysis of the gold data was completed. The automatic advance drive for the spectrometer arm of the Columbia neutron spectrometer at BNL was put into operation. Work was continued on transmission measurements. Electric monopole processes were studied following excitation of O^+ states in Ca^{40}, Ge^{72}, and Zr^{90} by inelastic proton scattering. The excitation function for inelastic and elastic scattering of protons from C^{12} was studied at several angles for E_ρ = 53 to 6.0 MeV. Gamma-coincidence studies and neutron spectroscopy suggested the existence of a previously unreported state at 1.8 MeV in Na^{21}. The reactions $Ne^{20}(p,\gamma)Na^{21}$ and $Ne^{20}(d,n)Na^{21}$ were investigated. An attempt to determine the population of the 7.65 MeV C^{12} state relative to that of the 4.43 MeV state in the $Be^9(\alpha,n)C^{12}$ reaction was made. Preliminary measurements of (He^3,T) reactions on Be^9 were made at energies of 2.5 to 3.5 MeV. Preparation was continued on the He^6 beta-neutrino angular-correlation experiment. Some preliminary investigations were carried out to detect the positrons from the internal-conversion pair from the O^+ to O^+ transition of Ca^{42}. The capture rate of the muon in C^{12} is calculated. A positioning unit for controlling the azimuth of a detector, capable of rotating in alternate directions in steps of 18°, was designed. Several vacuum-tube low-noise preamplifiers were developed. Several transistor coincidence circuits and a transistor limiter were investigated. A 10-channel time-of-flight analyzer was built and is being tested. (For preceding period see CU(PNPL)-199)

CU(PNPL)-203

Columbia Univ., New York. Pegram Nuclear Physics Labs.
PROGRESS REPORT FOR JANUARY, FEBRUARY, MARCH 1960 TO THE UNITED STATES ATOMIC ENERGY COMMISSION. 47p. (Contract AT-30-1-GEN-72)

Sixty-one resonances in I^{127} were analyzed up to an energy of 815 eV. In addition to the neutron width 18 values of radiation width were obtained. The new proton beam deflection circuitry was successfully tested. A fast neutron scintillation counter, which employs pulse-shape analysis for gamma rejection, is being tested. The associated circuitry, having a gamma lead time of 0.4 to 0.5 μsec, was developed. Measurements with the neutron spectrometer are described. Internal conversion electrons from the second excited state of Ca^{42} were observed in a magnetic spectrometer by proton inelastic scattering. Studies of $F^{19}(He^3,d)$ and $Li^7(He^3,d)$ at 3.5 MeV showed that no new states appeared in Be^8 in the energy gap of excitation 3 to 12 MeV, and that the intensity distribution of the d-spectrum from $Fe^{19}(He^3,d)$ is quite different from that of the n-spectrum leading to the same states in the $Fe^{19}(d,n)$ reaction. The charge exchange reaction using (He^3,T) on mirror nuclei Be^9 and Li^7 was investigated. A beam pipe assembly that consists of a strong focusing electrostatic lens, diffusion pump, and gas target was constructed and tested. The lifetime of the first excited state of Hg^{138} was measured using the double coincidence beta spectrometer. The anisotropy of the angular correlation between the 0.3 and 1.5 MeV γ-rays of Ca^{42} was investigated. A variable speed turntable assembly for preliminary Mössbauer effect studies was designed and constructed. A positioning unit for controlling the azimuth of a detector in a γ-γ angular correlation arrangement was designed. Development of a low-noise preamplifier is discussed. The ten-channel time-of-flight analyzer was completed after several modifications. A fast coincidence circuit was constructed and tested. (For preceding period see CU(PNPL)-202)

DC-59-12-221

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
PULSED NEUTRON MEASUREMENTS ON BERYLLIUM OXIDE. K. W. Seemann. December 1959. 15p. (Contract AT(11-1)-171)

GA-848

General Atomic Div., General Dynamics Corp., San Diego, Calif.
THE CONTINUOUS OPACITY AND EQUATIONS OF STATE OF LIGHT ELEMENTS AT LOW DENSITIES. Jeremy Bernstein and Freeman J. Dyson. July 1959. 35p. (Project No. 52) (Contract AF 19(600)-1812)

An approximate method for computing the opacity of light elements at low densities ($\sim 10^{-3}$ g/cm^3) in the Rydberg temperature range is described. Based on this method, a code was developed for which results for H, He, Li, Be, B, C, N, O, and F at various temperatures and densities are reported.

LA-2111

Los Alamos Scientific Lab., N. Mex.
NEUTRON EMISSION PROBABILITIES FROM THE INTERACTION OF 14-MeV NEUTRONS WITH Be, Ta, Bi, AND U^{238}. Louis Rosen and Leona Stewart. January 1957. Decl. May 1960. 27p. (Contract W-7405-eng-36)

The spatial and spectral distributions of the neutrons from 14-MeV neutron interactions with Ta, Bi, and U were obtained using nuclear

emulsion detectors in conjunction with a neutron collimator. The space-integrated neutron spectrum was obtained for Be by means of a sphere experiment. The cross sections derived from these measurements are tabulated.

LMSD-288140 (Vol. II) (Paper 1)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
ELECTRONIC STRUCTURE OF BERYLLIUM. Paper 1 of GENERAL RESEARCH IN MATERIALS AND PROPULSION, JANUARY 1959 TO JANUARY 1960. VOLUME II. G. C. Kuczynski. 26p.

This paper is a reprint from LMSD-288003 dated August 1959.

An attempt is made to correlate the structure-insensitive physical properties of beryllium on the basis of the theory of solids. Special attention is paid to the thermal, elastic, and electrical properties. An explanation of the decrease of lattice parameters ratio with temperature is proposed based on the Herring-Hill calculations of the wave functions for beryllium. Recommendations are made for experimental work toward the increase and completion of the information concerning the physical properties of beryllium.

NAA-SR-Memo-4579

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
COMPARATIVE PROPERTIES OF DISPERSION-ELEMENT COMPONENTS. J. Kroehler, Jr. September 1959. 11p.

Patented fissile materials and matrices available for use in OMR were compared. Thermal conductivities, coefficients of thermal expansion, cross sections, and relative amounts of wt. % contributed to the fuel element were compared for ten matrix materials. The most promising of these appeared to be Al, Be, Mg, and Zr. Uranium contents, absorption cross sections, and relative stabilities were compared for 15 fissile materials. The most promising of these dispersants appeared to be UC, UO_2, UC_2, UN_2, UN, and USi_2.

NAA-SR-Memo-5785

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
EVAPORATION RATE STUDIES. H. H. Hanlin. October 1960.

Calculation of evaporation rate as a function of temperature from vapor pressure data for Al, Be, Cr, Co, Ge, Cu, Au, Fe, Mg, Mn, Ni, Pt, Ag, Si, Sn, Ti, U and V in vacuum at 700-2100°F.

NP-8655 (p. 40-57)

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England
COLD NEUTRON RESEARCH AT HARWELL. p. 40-57 of PROCEEDINGS OF THE MEETING ON THE USE OF SLOW NEUTRONS TO INVESTIGATE THE SOLID STATE, STOCKHOLM, OCTOBER 1957. P. A. Egelstaff.

The development of a cold neutron source of high flux is discussed in some detail. Experiments carried out with the neutron source include neutron scattering on Be single crystals, cold-worked Cu, large crystals of silica, and lead single crystals.

NP-9255

Franklin Inst. Labs for Research and Development, Philadelphia
DEVELOP HIGH PURITY BERYLLIUM AND DETERMINE THE MECHANICAL PROPERTIES OF MATERIAL PRODUCED. BI-MONTHLY PROGRESS REPORT FOR PERIOD SEPTEMBER 1-OCTOBER 31, 1959. Marvin Herman and Grant E. Spangler. 3p. (Contract NOas-59-6242-c) (P-A2323-2)

The deformation and fracture characteristics of beryllium are reviewed. A technique was designed for fabricating electrolytic flake beryllium into rods.

ORNL-3085

Cornell Univ., Ithaca, N. Y.
PHOTON ABSORPTION BY VALENCE ELECTRONS IN NICKEL AND COPPER. TECHNICAL REPORT NO. 2. D. H. Tomboulian. April 1961.

Data are given for He^3 bombardment of Be^9, C^{13} and Li^7; neutron cross section of Pb^{208}, Se isotopes, Am^{241} and Np^{237}; Coulomb excitation of levels in Se^{77}; and Mossbauer method of HFS splitting of Au^{197} alloys with Fe, Co and Ni magnetic ordering.

ORNL-3193 (p. 215-222)

Oak Ridge National Lab., Tenn.
PULSED-NEUTRON MEASUREMENTS IN BERYLLIUM. E. G. Silver and G. deSaussure.

Neutron diffusion parameter measurements in Be at -100 to 25°C in order to verify theoretical calculations predicting large changes in this region.

PG-Report-171 (p. 55-72)

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England
THE DETERMINATION OF BERYLLIUM BY THE PHOTONEUTRON METHOD. G. W. C. Milner and J. W. Edwards.

PR-P-48

Atomic Energy of Canada Ltd., Chalk River Project, Chalk River, Ont.
PHYSICS DIVISION PROGRESS REPORT FOR OCTOBER1, 1960-DECEMBER 31, 1960.

Evaluation of energy levels and gamma yields for alpha irradiated Na^{23}, Si^{28}, Si^{30}, Be^9 and Mg^{26}. Investigation of the internal conversion electron spectrum in Dy^{161} following beta decay from Tb^{161} and the disintegration and decay schemes of Nd^{146}, Ba^{140} and Ce^{144}. Measurements are made of the total cross sections of single-crystal quartz.

R-58-CAP-25

Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.
A REVIEW OF THE PROPERTIES OF MATERIALS FOR ORGANIC COOLED REACTOR COOLANT TUBES. D. G. Boxall and A. R. Daniel. August 1958. 91p.

A review of the neutron absorption, corrosion resistance, irradiation damage, and mechanical properties of Be, Al-Fe alloys, steels, and Al, Mg, and Zr alloys for use in....

TID-7594 (Paper 7)
Yale Univ. , New Haven
TOTAL ABSORPTION ANTICOINCIDENCE SPECTROMETER. Paper 7 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. C. O. Bostrom and J. E. Draper. p. 71-9.

A total absorption anticoincidence NaI(Rl) spectrometer was used to measure gamma-ray spectra from thermal neutron capture in a variety of elements. The spectra include those of H, Be, B, Cl, Fe, Ni, Hg, and Pb. Examples of these spectra are presented as well as analysis of the energy dependence of efficiency, resolution, and line shapes.

TID-11561
General Electric Co. Aircraft Nuclear Propulsion Dept. , Cincinnati
THE STATUS OF NEUTRON CROSS SECTIONS AND RELATED DATA. A. Prince. October 1960. 97p. (XDC-60-11-164) (Contracts AF 33(600)-38062 and AT(11-1)-171)

The current status of experimentally defined neutron cross sections for materials pertinent to shield analysis is presented. The experimental and theoretical techniques employed in obtaining data are outlined. Materials included are: H, Li, Be, R, C, N, O, Al, Cr, Fe, Co, Ni, Yb, Zr, Mo, W, Pb, and U.

UCRL-3230
California. Univ. , Berkeley. Radiation Lab.
BREMSSTRAHLUNG FROM PROTON BOMBARDMENT OF NUCLEI. David Cohen. December 1955. 74p. (Contract W-7405-eng-48)

Various targets were bombarded with protons in the 40 to 140 MeV region, and the gamma spectra were detected and analyzed. Under the assumption that the gamma rays originated from the deflected protons, the purpose of the experiment was to obtain information about the nature of the nuclear interactions through which the protons suffered changes of states. Targets of Cu, Al, C, and Be were placed in the synchrocyclotron and viewed with a pair spectrometer.

UK-10
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England
EUROPEAN ATOMIC ENERGY SOCIETY – STOCKHOLM 1959 – THE EFFECT OF IRRADIATION UPON BERYLLIUM. Robert S. Barnes. 3p.

XDC-58-4-58
General Electric Co. Aircraft Nuclear Propulsion Dept. , Cincinnati
THE EFFECT OF BERYLLIUM PHOTONEUTRONS ON REACTIVITY. R. K. Lane. March 1958. Decl. June 1961. 24p. (Contract AT(11-1)-171).

Calculation of the gamma slowing down density and the contribution to reactivity from Be photoneutrons.

SECTION III

BERYLLIUM COMPOUNDS

Achacinskij, V. V. and L. M. Kopytin
HEAT OF FORMATION OF $PuBe_{13}$. Kernenergie, v. 4: 519-20 (June 1961) (German)

Alcock, C. B.
FORMATION OF VOLATILE OXIDES BY FURNACE CONSTRUCTION MATERIALS. Transactions of the British Ceramic Society, v. 60: 147-164 (Feb. 1961)

Data are collected for most of the common elements and oxides used in the construction of high temperature apparatus. Discussion of the experimental methods by which the data are obtained, with derived free energy of formation equations.

Anderson, A. R. and T. M. Stickney
CERAMIC RESISTANCE THERMOMETERS AS TEMPERATURE SENSORS ABOVE 2200°R. Instruments and Control Systems, v. 34: 1864-1868 (Oct. 1961)

Austin, S. M.
THE POLARIZATION OF NEUTRONS FROM THE $Li^7(p,n)Be^7$ REACTION. The University of Wisconsin, 1960

Balaban, A. T., E. Barabas, and M. Farcasiu
DIACETYLATION OF 2-METHYLBUT-2-ENE CATALYSED BY BERYLLIUM CHLORIDE. Chemistry & Industry, no. 17: 781-782 (April 1962)

Barchiesi, G.
BERYLLIUM BRONZES. Fonderia, v. 10: 548-551 (Dec. 1961) (Italian)

Survey of specific gravity, magnetism, melting point, specific heat, elastic modulus, expansion coefficient, tensile strength, elongation, Brinell hardness, thermal and electric conductivity of Cu-Be bronzes containing 0.45-2.75% of Be and 0.36-2.60% of Co. Review of hardening, melting, solubilization, forming and casting processes. Effect of Co and Be on fragility and wear resistance and effect of NH_4OH and Hg on corrosion resistance.

Borovkov, I. V.
ANODE PASSIVATION OF COPPER AND SOME OF ITS ALLOYS IN PHOSPHATES. PAPER FROM SOVIET ELECTROCHEMISTRY, v. 2. OXIDATION AND REDUCTION. Consultants Bureau, Inc., New York 11, 1959, p. 249-252

Investigation of the anode passivity of pure Cu, Cu-Be and Cu-An alloys, and bronze specimens in phosphate solutions of varying composition as a function of H+ ion concentration, current density, nature of the alloy, arrangement of the anodes and temperature.

Buchler, Alfred
THERMODYNAMIC PROPERTIES OF SOME GASEOUS METAL COMPOUNDS. Chemical Engineering Progress Symposium Series, v. 57: 46-52 (1961)

Chollet, M. L.
ELECTRICAL RESISTANCE AND METALLOGRAPHY. Microtecnic, v. 15: 203-207 (Oct. 1961)

Dayton, R. W. and E. M. Simons (Battelle Memorial Inst., Columbus, Ohio)
REACTOR CORE MATERIALS. Quarterly Technical Progress Review, v. 3, no. 1, 60 p. (Feb. 1960)
Fuel and Fertile Materials. A review of developments in U, alpha-U alloys, gamma-phase U alloys, dilute U alloys, Pu and its alloys, Th and its alloys, dispersion fuel elements, refractory fuel and fertile materials, diffusion studies, mechanism of corrosion of fuel alloys, and basic studies of radiation effects in fuel materials is reported. Moderator Materials. Development in graphite, Be metal and alloys, Be compounds, and solid hydrides is reported. Nuclear Poisons. Research and development are reported in metallic poison materials and dispersion-control materials. Cladding and Structural Materials. Research on corrosion, radiation effects in nonfuel materials, selected metallurgical aspects of cladding and structural materials, and selected mechanical properties of cladding and structural materials is presented. Special Fabrication Techniques. Developments are reported in melting and fabrication, cladding, explosion forming, welding and brazing, and nondestructive testing.

Dayton, R. W., E. M. Simons, and R. W. Endebrock, eds. (Battelle Memorial Inst., Columbus, Ohio)
REACTOR CORE MATERIALS. Technical Progress Review, v. 4, no. 2 (May 1961)

Dayton, R. W., E. M. Simons, and R. W. Endebrock (Battelle Memorial Inst., Columbus, Ohio)
REACTOR CORE MATERIALS. Technical Progress Review, v. 3, no. 3 (1960) 64 p.
Fuel and Fertile Materials. A review is made of developments in uranium, α-phase uranium alloys, γ-phase uranium alloys, ϵ-phase uranium alloys, dilute uranium alloys, plutonium, thorium, dispersion fuel materials, refractory fuel and fertile materials, mechanism of corrosion of fuel alloys, and basic studies of irradiation effects in fuel. Moderator Materials. Developments in graphite, beryllium metal, beryllium compounds, and solid hydrides are reported. Nuclear Poisons. Research and development are reported. Cladding and Structural Materials. Research is reported on corrosion, radiation effects in nonfuel materials, selected metallurgical aspects of cladding and structural materials, and selected mechanical properties of cladding and structural materials. Special Fabrication Techniques. Developments are reported in melting, casting, heat-treatment, hot-working, cladding, explosive forming, welding, brazing, and nondestructive testing.

Dvir, M. and W. Low
PARAMAGENTIC RESONANCE AND OPTICAL SPECTRUM OF IRON IN BERYL. Physical Review, v. 119: 1587-1591 (Sept. 1960)
The paramagnetic resonance spectrum of Fe^{3+} in beryl was measured at 20° and 290°K. In addition to this spectrum many weak lines were observed and possible explanations of these lines are discussed.
The optical spectrum shows a spectrum characteristic of trivalent iron. In the infrared region there are several groups of sharp lines whose origin is not yet known.

Exline, P. G.
BOURDON TUBE DEFLECTION CHARACTERISTICS. American Society of Mechanical Engineers, Transactions, v. 82: 887-893 (Dec. 1960)
Measuring the deflection characteristics of 50 Bourdon tubes constructed of steel, bronze, 316 stainless steel and Be-Co alloy. Data for performance, pressure sensitivity ratio, wall thickness axial ratio and geometric parameters.

Gordon, L. J.
HIGH TEMPERATURE EQUILIBRIA INVOLVING METALLIC HALIDES. Ars Journal, v. 30: 978-979 (Oct. 1960)
Simplified calculation of high temperature equilibria for a system containing a multivalent metal such as Be, Mg, B, Al, C, Si, and Ti and more than one halide.

Hessinger, P. S.
BERYLLIA-ENGINEERED SPACE AGE MATERIAL. I. & EC (Industrial and Engineering Chemistry), v. 54: 16-21 (March 1962)

Hochstetter, Friedrich
PRODUCTION OF BERYLLIUM. Chemiker-Zeitung, v. 86: 108-109 (February 1962) (German)

Hoenig, C. L., C. F. Cline, and D. E. Sands
INVESTIGATION OF THE SYSTEM BERYLLIUM-BORON. American Ceramic Society Journal, v. 44: 385-389 (August 1961)

Hoffman, J. A., G. R. Baxter, R. C. Bertossa, and B. R. Cottrell
DIFFUSION BONDING BERYLLIUM COPPER FOR ULTRA HIGH-STRENGTH JOINTS. Welding Journal, v. 41: 160s-166s (April 1962)

Hotchkiss, E. B.
BERYLLIUM. Mining Congress Journal (Annual Review, 1961), v. 48: 105-107 (February 1962)

Hyde, K. R., F. L. Robinson, M. J. Waterman, and J. M. Waters
REACTION OF BERYL WITH SODIUM FLUOROSILICATE USED IN EXTRACTING BERYLLIUM FROM THE MINERAL. The Institution of Mining and Metallurgy Bulletin, v. 70: 397-406 (April 1961)
An analysis of the chemical reaction of beryl with sodium fluorosilicate and its decomposition products, sodium fluoride and silicon tetrafluoride. Results of tests to determine the effects of rasting temperature and time, atmospheres and beryl particle size on the Be extraction rate and on the formation of sodium fluoroberyllate glass, cryolite, A-cristobalite and albite.

Jacquet, P. A.
NONDESTRUCTIVE METALLOGRAPHY OF Al, Mg, Be, AND THEIR ALLOYS. CONCLUSION. Revue de L'Aluminum, v. 37: 977-987 (Sept. 1960) (French)

Jones, L. V., D. E. Etter, and C. R. Hudgens
PHASE EQUILIBRIA IN THE TERNARY FUSED-SALT SYSTEM $LiF-BeF_2-UF_4$. American Ceramic Society Journal, v. 45: 79-83 (February 1962)

Judge, John
BERYLLIDES BOOST TEMPERATURE LEVEL. Missiles and Rockets, v. 9: 36-37 (Nov. 1961)

Kida, K., M. Abe, S. Nishigaki, and K. Kobayashi
COULOMETRIC DETERMINATION OF Be IN Be-Cu AND Be-Al ALLOYS, Japan Analyst, v. 9: 1031-1035 (Dec. 1960)
Determination of Be with 8-hydroxyquiraldine in alloy specimens containing 1-5% Be using KCN for masking Cu and EDTA for masking Al. Effect of masking agents on the absorbancy of the Be complex.

Kida, K., M. Abe, S. Nishigaki, and T. Kusaka
CALORIMETRIC RAPID DETERMINATION OF SILICON IN COPPER-BERYLLIUM ALLOYS. Japan Analyst, v. 10: 358-362 (April 1961) (Japanese)
Determination of the Si concentration in Cu-Be alloys by measurement of the absorption of molybdenum blue.

Kolomoitsev, F. E., V. P. Izotov, and E. V. Stauer
THE LUMINESCENCE OF POWDERED PHOSPHORS IN AN ELECTRIC FIELD. Optics and Spectroscopy, v. 12: 64-65 (January 1962)

Kripyakevich, P. I., M. A. Tylkina, and E. M. Savitskii
CRYSTAL STRUCTURES OF HAFNIUM-BERYLLIUM COMPOUNDS. Soviet Physics – Crystallography, v. 6: 94 (July-August 1961) (Translation – AIP)

Kripyakevich, P. K., M. A. Tylkyna, and E. M. Savitskii
CRYSTAL STRUCTURES AND CERTAIN PROPERTIES OF HAFNIUM-BERYLLIUM COMPOUNDS. Journal of Structural Chemistry, v. 2: 395-402 (July-August 1961) (Translation)

Kuhn, J. B.
HOW TO HEAT TREAT BERYLLIUM COPPER. Metal Progress, v. 81: 87-91 (June 1962)

Lainer, A. I., V. I. Hanopolskiy, and M. A. Kolenkova
STUDY OF THE PROCESS OF OBTAINING BASIC BERYLLIUM CARBONATE. Izvestiya VUZ – Tsvetnaya Metallurgiya: 75-80 (March 1961) (Russian)
Obtaining the stable compound by mixing and hydrolysis of beryllium sulphite with crystalline ammonia carbonate.

Lippman, D. and M. P. Stoltenberg
HEAT STORAGE MATERIALS. Lithium Corp. of America, Inc., 500 Fifth Ave., New York 16, N. Y., June 1961, 108 p.

McClelland, J. D. and W. C. Riley
CERAMICS FOR UP TO 2100°C. Space/Aeronautics, v. 37: 111-112 (April 1962)

Effect of temperature (1500-2100°C) on oxidation resistance, thermal conductivity, shock resistance, strength, ductility and rupture modulus of ceramics and intermetallics: Ta_2Be_{17}, $CbBe_{12}$, $MoBe_{12}$, $ZrBe_{13}$, Zr_2Be_{17}, TiB_2, CbB_2, ZrB_2, TaB_2, HfB_2, nitride, silicide, titanium carbide, zirconium carbide, hafnium carbide, tantalum carbide, columbium carbide and AgCl.

Mackenzie, J. D.
STRUCTURE OF GLASS FORMING HALIDES. I. LIQUID BERYLLIUM FLUORIDE. J. Chem. Phys., v. 32, no. 4: 1150-2 (April 1960)

Viscosity and electric conductivity measurements were made on liquid beryllium fluoride over the temperature range 700-950°C. The high specific resistance and viscosity and the magnitude of the corresponding energies of activation indicate that the classical random network structure for glasses is applicable. Liquid BeF_2, similar to liquid GeO_2 and SiO_2, is highly associated even at elevated temperatures. At a temperature 200° above the melting point, the energy of activation for viscous flow is greater than the heat of vaporization. The ease of glass formation is attributed to the network structure of the liquid.

Mackenzie, J. D.
VISCOSITY-TEMPERATURE RELATION FOR NETWORK LIQUIDS. Journal of the American Ceramic Society, v. 44: 598-601 (Dec. 1961)

Markovskii, L. Ya. and G. S. Markevich
DETERMINATION OF SOFTENING TEMPERATURES IN THE BERYLLIUM RICH REGION OF THE BERYLLIUM-BORON SYSTEM. Journal of Applied Chemistry of the USSR, v. 33: 1647-1648 (July 1960) (Translation)

Softening temperatures, corresponding to their bending, are determined on samples made by sintering boron and Be powders. Data are used to conform earlier investigations on phase relationships in the system.

Morrison, R. D.
THE RELATIONSHIP BETWEEN STRUCTURAL CHARACTERISTICS AND MAGNETIC PROPERTIES OF AGED IRON-BERYLLIUM ALLOYS. Lehigh University, 1960.

Iron and beryllium are known to form alloys of the precipitation hardening type. Beryllium is soluble in alpha iron to the extent of 7.5 weight percent at 1165°C. Upon aging at temperatures where the solubility of beryllium is lower, precipitation of a second phase occurs and magnetic and mechanical properties undergo substantial changes. At high aging temperatures, both coercivity and hardness increase, while at lower aging temperatures, only hardness increases with coercivity remaining essentially constant at the solution treated value.

The above results imply that more than one mechanism is actively influencing hardness, depending on the temperature at which the precipitate forms. The two mechanisms considered are hardening by coherency strains and dispersion hardening. In the more general case, both of these mechanisms affect coercivity.

Magnetic measurements interpreted in terms of the combined theories of Néel and Kersten indicate that for low temperature aging (300 °C) the lattice is strained through coherency effects, however the nature of the strain being such as to cause no change in coercivity while greatly increasing mechanical hardness. At higher aging temperatures (500 °C) this strain apparently does not develop indicating that at these temperatures, the appreciable increase in coercivity is due to the presence of a second phase. Calculations of the volume of second phase present are consistent with the amount actually present, considering the probable lack of sphericity of the precipitate particles.

X-ray diffraction investigation coupled with metallographic examination revealed the habit plane to be {011}. There is also evidence for the following orientation relationship between the matrix and the hexagonal $FeBe_2$ precipitate:

$$(011) // (0001)$$
$$[1\bar{1}1] // [10\bar{1}0]$$

Conclusive evidence for this relationship was not obtainable however.

Further evidence that the precipitate is coherent when formed at 300 °C is demonstrated by the observation of basal parameters of the precipitate. At 600 °C the basal parameter approaches the value for the equilibrium second phase while for very long times at 300 °C the parameter remains essentially unchanged at a value indicating a precipitate composition well outside the solubility range of $FeBe_2$. This indicates that at 300 °C coherency effects are exerting a continuing influence on the precipitate structure.

Murray, P. and J. Williams
CERAMIC AND CERMET FUELS. PAPER FROM PROGRESS AND NUCLEAR ENERGY. SERIES 5. METALLURGY AND FUELS. Vol. 4. METALLURGY OF NUCLEAR REACTOR COMPONENTS. Pergamon Press, Inc., New York 22, 1961, p. 520-542

Novikov, M. M. and L. N. Tunitskii
VIBRATIONAL CONSTANTS AND DISSOCIATION ENERGY OF THE BeCl MOLECULE. Optics & Spectroscopy, v. 8: 396-399 (June 1960)

The vibrational structure of the bands of the BeCl molecule has been restudied. Thirty new heads of the Q_1-branches of the bands and 43 new heads of the R_1- and R_2-branches have been found. The values of the vibrational constants ω_0 and $\omega_0 x_0$ in the upper and lower states have been made more precise, and the second anharmonicity coefficients $\omega_0 y_0$ have been determined for the $A^2\Pi$ and $X^2\Sigma$ states. The value of the third anharmonicity coefficient for the $X^2\Sigma$ state has been estimated. A nonlinear extrapolation has been carried out and a new most probable value for the dissociation energy of the BeCl molecule is given: 5.9 ± 0.5 ev. In the 2620 A region, new bands have been discovered, which apparently are to be ascribed to a transition from a new, higher electronic state of the BeCl molecule.

Novoselova, A. V.
BERYLLIUM FLUORIDE AND FLUOROBERYLLATES. Translated by C. B. Finch (Oak Ridge National Lab.) from Uspekhi Khim. 27, 33-43 (1959) 21p. (AEC-tr-3992)

Ohta, K. and Y. Kobayashi
MAGNETIC PROPERTIES OF THE IRON-BERYLLIUM COMPOUNDS WITH THE HEXAGONAL STRUCTURE. Kobayasi Institute of Physical Research Bulletin, v. 11: 61-64 (July-Sept. 1961) (Japanese)

Reinbach, R. and U. Wilke-Dorfurt
FORMATION OF AN INTERMEDIATE PHASE IN THE AGING OF COPPER-BERYLLIUM ALLOYS. Zeitschrift fur Metallkunde, v. 52: 186-188 (March 1961) (German)

Rief, Herbert
THE FAST EFFECT IN URANIUM AND BERYLLIUM SYSTEMS. Nuclear Science and Engineering, v. 10: 83-89 (May 1961)
A Monte Carlo code is used to calculate the fast effect in both homogeneous and heterogeneous systems. Natural uranium, natural Be and beryllium oxide are investigated. Calculations are also carried out for uranium-water lattices and compared with experimental results for slightly enriched uranium rods and slabs and uranium oxide rods.

Riley, W. C. and J. D. McClelland
BERYLLIUM COMPOUNDS. Space/Aeronautics, v. 37: 74-77 (May 1962)

Rudy, E., F. Benesovsky, H. Nowotny, and L. E. Toth
CRYSTAL STRUCTURE OF $HfBe_2$, $HfBe_{13}$, AND HfBeSi: PARTIAL SYSTEMS $MeBe_2$-MeB_2-$MeSi_2$ (Me = Zr, Hf). Monatshefte fur Chemie, v. 92: 692-700 (March 1961) (German)

Seala, E.
COMPOSITE MATERIALS FOR THERMAL PROTECTION. Metals Review, v. 33: 4-9 (Nov. 1960)

Snyder, M. J. and A. B. Tripler, Jr.
REFRACTORY URANIUM COMPOUNDS - PREPARATION AND PROPERTIES. PAPER FROM MATERIALS IN NUCLEAR APPLICATION. American Society of Testing Materials, Special Technical Pub. 276: 293-300 (1960)
Methods for preparing dense specimens of UC, UC_2, UN, UB_2, and UBe_{13}. Thermal expansion, thermal conductivity, microhardness and reactivity with water vapor, oxygen and nitrogen at temperatures up to 500°C.

Strukov, B. A., N. D. Gavrilyuk, and V. A. Koptsik
SOME ASPECTS OF THE FERROELECTRIC PHASE TRANSITION IN $(NH_4)_2BeF_4$. Soviet Physics - Crystallography, v. 6: 625-27 (March-April 1962) (Translation)

Thilo, E. and H. Schröder
THE NaF-BeF_2 SYSTEM AND ITS RELATION TO THE CaO-SiO_2 SYSTEM. EXAMINATION OF SILICATE MODELS II. Translated by R. Todd (U.K.A.E.A. Atomic Energy Research Establishment) from Z. physik. Chem. (Leipzig) 197A, 39-62 (1951) 27p (AERE-Trans-844)
The thermal phase diagram of the system NaF-BeF_2 is plotted for BeF_2 contents up to 61 mole %, and is compared with that for the system CaO-SiO_2. The two systems show a perfect model-relationship. Almost all the invariant points of the fluoride system (reckoned in °K) are converted to those of the silicate system by multiplying by 2.82.

(For comparison of the systems $LiF-BeF_2$ and $MgO-SiO_2$, this factor has the value 2.88.) The following definite compounds were found and their melting points were determined: NaF 990°C, Na_2BeF_4 578, $NaBeF_3$ 372, $Na_3Be_2F_7$ (incongruent) 348°C. The eutectic NaF-Na_2BeF_4 at 31 mole % BeF_2 melts at 560°; and the $Na_3Be_2F_7$-$NaBeF_3$ eutectic (44.3 mole % BeF_2) melts at 340°. In the subsidiary system NaF-Na_2BeF_4, the compound Na_3BeF_5 (analogous to Ca_3SiO_5) was found to result from a solid-state reaction, and the γ- and β-modifications of Na_2BeF_4 were identified with certainty. Three further modifications were established with a high degree of probability, and the β- and α-modifications of $NaBeF_3$ were identified. The transition temperatures relating to all these modifications were determined. It is shown in the final section that the thermal decomposition of $(NH_4)_2BeF_4$ takes place in two stages; the intermediate product NH_4BeF_3, which is stable between 230 and 270°C, has a characteristic x-ray diagram.

Thomas, Hans
INTERMEDIATE PHASES IN AGE HARDENING OF COPPER-BERYLLIUM ALLOYS. Zeitschrift fur Metallkunde, v. 52: 750-753 (Nov. 1961) (German)

Westbrook, J. H., ed.
MECHANICAL PROPERTIES OF INTERMETALLIC COMPOUNDS. A SYMPOSIUM HELD DURING THE 115TH MEETING OF THE ELECTROCHEMICAL SOCIETY AT PHILADELPHIA, PENNSYLVANIA, MAY 3-7, 1959. John Wiley & Sons, Inc., New York, 1960, 446p.

Seventeen papers are included which were presented at a symposium held in Philadelphia on May 5 to 6, 1959. (Separate abstracts have been prepared for three.) The subjects of the papers are effects of crystal structure and temperature, experimental techniques for studying mechanical properties, effects of dislocations and point defects, and properties of specific compounds. Some of the compounds treated are NiAl and Ni_3Al (fractography), Cu-Au alloys (domain structure). TiAl (radiation effects), InSb, transition metal beryllides, Cu-Al alloys (plasticity of complex phase), intermetallic compounds of transition metals, and Fe-Ni alloys.

Engineer, v. 212, Dec. 15, 1961, p. 1018-1020
PHASE-EQUILIBRIUM STUDIES IN METALLURGICAL SYSTEMS.

Iron Age, v. 188, Nov. 9, 1961, p. 113-115
BERYLLIDES: NEW MATERIALS FOR SPACE AGE STRUCTURES.

Metal Industry, v. 99, Nov. 10, 1961, p. 378-79
PROTECTION AGAINST METAL FATIGUE.

Metal Industry, v. 99, Dec. 15, 1961, p. 473
METALS IN SPACE.

Metal Progress, v. 80, Dec. 1961, p. 9
BERYLLIDES – NEW HIGH TEMPERATURE MATERIALS.

Metal Progress, v. 81, Jan. 1962, p. 9
FINE GRAIN Be-Cu ALLOYS PRODUCE QUALITY CASTINGS.

Pre-alloying of Be-Cu ingot with a grain refining element (Co) to further assure fine grain. The fine grain results from a superabundance of nucleation sites on solidification.

Reactor Core Materials, v. 3, Nov. 1960, p. 19-27
MODERATOR MATERIALS.

Effect of refining, melting, casting, electron-beam welding, and fabrication on physical and mechanical properties of Be and Be alloys. Data given for density, hardness, UTS, thermal expansion and conductivity, specific heat, electrical resistivity and electromagnetic units of Zr, Yt, Ba and alloy hydrides.

Space Aeronautics, v. 35, Jan. 1961, p. 72-73
CRYOGENIC MATERIALS.

AD-238031

Armour Research Foundation, Chicago, Ill.
DUCTILE BERYLLIUM ALLOYS. Bimonthly rept. no. 3, Jan., Feb., Mar. 60, 7p. incl. illus. (Rept. no. ARF 2187-3) (Contract NOa(s) 60-6036-c)

An envelope-type microstructure prepared by liquid phase sintering is being investigated as a means of producing ductile beryllium alloys. Results for seven new compacts are reported. A germanium addition was found to be highly beneficial to a silver matrix compact as well as for aluminum matrix compacts. A Be-65Ag-1Ge (75 volume per cent beryllium) compact was reduced 70% by cold pressing. The microhardness of beryllium particles in several highly plastic compacts was found to be from 90 to 150 higher in DPH values than for relatively low plasticity compacts. Plastic deformation decreased the apparent hardness of the "hard" beryllium grains.

AD-238214

Georgia Inst. of Tech. Engineering Experiment Station, Atlanta
INVESTIGATION OF HIGH TEMPERATURE RESISTANT MATERIALS. C. R. Mason, J. D. Walton, and others. Quarterly rept. no. 17, Feb-Apr. 60, 45p. incl. illus. tables. (Contract NOrd-15701, Proj. A-212)

Thermal Protection Systems: Conductivity measurements of 2 samples of unicellular foamed fused SiO_2 increased rapidly with increased temperature and at a higher mean temperature than expected. The maximum heat flux in the exhaust of the 40-kw arc-plasma unit, using synthetic air formed downstream of the primary nozzle, was 500 Btu/sq ft-sec at a distance of 0.5 in. from the mixing nozzle exit. A Cu block device for stagnation pressure measurements was used to measure pressures in the exhaust of the plasma unit; its large mass and high conduction properties permitted a relatively long exposure time in the high-temperature gases. Coatings: The thermal expansion for arc-sprayed alumina, titania, and zircon was measured at 0° to 1000°C by the use of a fused quartz type of expansion apparatus; a sudden decrease in thermal expansion of the titania sample may be due to a crystal structure change; thermal expansions for alumina and zircon show no radical changes. Indicated tensile strengths of arc-sprayed alumina, tungsten, and Tetco 101 were in the 4000- to 5000-psi range. Thermets: Effects of varying thermite content on thermets having a final composition of 65% Cr and 35% BeO_2 indicated that the best properties were obtained in thermets whose original thermite content was 40 to 45%. Cr_3C_2 and Cr_7C_3 were identified by x-ray analysis in the products of the thermite reaction of Be, Cr_2O_3, and graphite.

AD-238225

Little, Arthur D., Inc., Cambridge, Mass.
IONIC-MODEL CALCULATIONS: II. THE BENDING FORCE CONSTANTS OF THE GROUP II HALIDES. Alfred Buchler. Interim technical rept. no. 3 on Study of High-Temperature Thermodynamics of Light-Metal Compounds, April 60, 20p. incl. illus. tables. (Contract DA 19-020-ORD-4829) (OOR rept. no. 006-3)

The bending force constants of the Group II halides have been calculated for three versions of an ionic model of these molecules. The first version treats the ions as point charges; the second includes their dipole polarizabilities; the third is based on a multipole expansion that includes all terms up to the charge-(induced octupole) term. The calculations show that the ionic model cannot account for the observed magnitude of the bending force constants.

AD-239350

Lockheed Aircraft Corp., Sunnyvale, Calif.
GRAIN REFINEMENT IN BERYLLIUM BY ALLOYING. D. Crooks and H. Sumsion. Summary rept. July 58, Dec. 59, Jan. 60, 1 v. incl. illus. tables. (Rept. no. LMSD-288233) (Contract NOrd-17017)

A literature review is presented on the lack of ductility in Be and the effect of purity on ductility, with particular reference to the effect of alloying upon grain refinement of the cast metal. The results are presented of a screening evaluation of each button in terms of hardness, grain refinement, and apparent ductility for about 100 Be-rich alloys. Buttons of these alloys (1 to 2 g) were prepared by arc-melting (a minimum of 8 times each) with a non-consumable W electrode in a purified Ar atmosphere on a water-cooled Cu hearth. The buttons were sectioned through the vertical axis and each half was ground flat for Rockwell B hardness determinations. An empirical method was established for evaluating the as-cast buttons in comparison with unalloyed Be. Apparent ductility is the ratio (percent) of the number of hardness indentations showing no edge-cracking to the total number of hardness indentations. Greater hardness for the alloy was assumed to indicate increased brittleness over that of unalloyed Be. Grain refinement evaluation was based on the number of equiaxed grains produced and the relative reduction in size of the remaining columnar grains as compared to those of unalloyed Be. Alloys selected for further investigation were the binary alloys of Si, Ag, and Al with Be; the ternaries of Si, Ag, and Al with Be-rich Ti; and the ternary of Al and Si with Be.

AD-239695

Armour Research Foundation, Chicago, Ill.
DUCTILE BERYLLIUM ALLOYS. F. A. Crossley and R. J. Van Thyne. Bimonthly rept. no. 4, March, April, May 60, 5p. incl. tables (Rept. no. ARF 2187-4) (Contract NOa(s) 60-6036-c)

An envelope-type microstructure prepared by liquid-phase sintering is being investigated as a means of producing ductile beryllium alloys. Partial results of evaluations of five compacts with ternary additions are reported. Ternary additions of cerium or yttrium were made to aluminum matrix compacts and of calcium, cerium, or yttrium to silver matrix compacts. The ternary additions are being tested for their effect on sinterability. Three compacts of the Be-31Al-2Ge alloy made with beryllium powders representing two sources and two particle

size ranges were partially evaluated by cold pressing, annealing at 500°C for 2 hr, and then cold rolling. Total cold reductions to fracture were in the range from 36 to 43%. Alloys of the Be-Al-Ge system containing 6.4, 3.5, and 2.1 vol. % matrix, respectively, were not successfully sintered at 950°C for 1 hr. A Be-65Ag-1Ge compact was partially evaluated by cold pressing, annealing at 500°C for 2 hr, and cold rolling; total cold reduction was 47%.

AD-240614

Armour Research Foundation, Chicago, Ill.
DUCTILE BERYLLIUM ALLOYS. F. A. Crossley and R. J. Van Thyne. Bimonthly rept. no. 5, May, June, July 60, 11p. incl. illus. tables (Rept. no. ARF 2187-5) (Contract NOa(s) 60-6036-c)

An envelope-type microstructure prepared by liquid-phase sintering is being investigated as a means of producing ductile beryllium alloys. Having demonstrated sinterability for 25 vol. % matrix alloys of the Be-Al-Ge and Be-Ag-Ge systems, efforts were directed towards developing alloys of lower matrix content. Previous work at the Foundation has given considerable evidence that matching hardness of the matrix with the principal phase is mandatory for high ductility compacts. Accordingly, quaternary additions for strengthening the matrix were investigated. The most promising alloy system is Be-Ag-Al-Ge. The hardening reaction in the silver-rich matrix of this alloy system is a peritectoid reaction $\alpha + \gamma - \beta$. Show cooling from above the peritectoid reaction temperature of 390°C, or quenching from above this temperature and aging below it, results in hardnesses up to three times higher than those achievable in the Ag-7.5 wt % Cu age hardening alloy. Alloys of Be-Ag-Al-Ge systems nominally containing 10 and 15 vol. % matrix were liquid phase sintered under pressure to eliminate voids. Pressure sintering apparently squeezed out some of the matrix so that the resulting compacts contained less than 10 vol. % matrix and probably about 5 vol. %. The compacts were very tough. This was especially evident in abrasion cutting. Two compacts were cold reduced 60% although cracking initiated at 18% reduction. These alloys are standouts among those investigated to date. They show real promise.

AD-240705

Magnetic Materials Lab., Lehigh U., Bethlehem, Pa.
MAGNETIC MATERIALS RESEARCH. George P. Conard, II, H. Suprinick, and others. Quarterly rept. no. 7, Feb., May, June 60, 67p. incl. illus. tables.

Room temperature magnetostriction measurements were made on Fe-Be alloys. For Fe containing 3.25% Be, aged at 300°C after solution treatment, the coercivity remained constant and was attributed to internal stresses in the supersaturated solid solution. As the aging progressed the stress increased greatly, but was active in a much smaller volume of the material. After 6 hr at 300°C, about 7% of the material was stressed in the vicinity of 1.76×10^9 dynes/cm^2, or 25,000 psi. After 12 hr at 300°C, about 3% of the matrix was stressed to about 2.89×10^9 dynes/cm^2, or about 40,000 psi. The results also indicated the existence of coherency for aging times up to 12 hr at 300°C. At aging temperatures of 500°C, the results indicated that stresses within the material are no longer significant, i.e., coherency

is not maintained and coercivity is increased primarily as a result of the development of a second phase. There appeared to be at least one strong magnetic phase of composition near Mn_2Si_2C. In view of the magnetic properties obtained in the Ni films, it is proposed that a critical thickness exists above which the film is no longer spontaneously magnetized in its plane. The optimum processing conditions for thin Co film production by thermal decomposition of cobalt acetylacetonate appears to be: 320° to 340°C substrate temperature. 140° to 150°C generator temperature, 5 to 10 min deposition time, and 3.6 to 5.4 l/min carrier gas flow rate.

AD-242258

Hebrew U. (Israel)
PARAMAGNETIC RESONANCE AND OPTICAL SPECTRUM OF IRON IN BERYL. M. Dvir and W. Low. Technical note no. 13, May 60, 20p. incl. illus. (Contract AF 61(052)59) (AFOSR TN 60-994)

The paramagnetic resonance spectrum of Fe^{3+} in beryl was measured at 20° and 290°K. In addition to this spectrum many weak lines were observed and possible explanations of these lines are discussed. The optical spectrum shows a spectrum characteristic of trivalent iron. In the infrared region there are several groups of sharp lines whose origin is not yet known.

AD-245439

Beryllium Corp., Reading, Pa.
BERYLLIUM CASTING. K. C. Taber and R. C. Harris. Interim technical rept. no. 8 on Phase 2, June - Sept. 60, 30p. incl. illus. tables. (Contract AF 33(600)37902)

An evaluation of alloy additions of lanthanum and zirconium is described. The results of alloy additions of lanthanum give increasing columnar grain refinement with increasing alloy additions. Zirconium as an alloying grain refiner has an optimum concentration of 0.40 to 0.60 weight percent for maximum columnar grain refinement. The step castings show the reduction of columnar grain size by increasing the cooling rate. Heat treating with prior cold reduction to promote recrystallization of the cast structure has yielded tentative relationships for recrystallization time and temperature for ten percent cold bare rolled cast beryllium. A trend has been observed with an optimum percent cold reduction for a given heat treatment for maximum grain refinement.

AD-247420

Armour Research Foundation, Chicago, Ill.
DUCTILE BERYLLIUM ALLOYS. Final rept. Sept. 59, Aug.-Oct. 60, 41p. incl. illus. tables. (Rept. no. ARF 2187-6) (Contract NOa(s) 60-6036-c)

An envelope-type microstructure prepared by liquid-phase sintering was investigated as a means of producing ductile beryllium alloys. Ternary additions of calcium, cerium, germanium, lanthanum, lithium, and yttrium were made to aluminum and silver matrix alloys to evaluate their effect in promoting sinterability. Germanium was effective in producing desirable two-phase structures. Macroporosity was eliminated in compacts containing 15% or less volume of matrix by sintering under a pressure of 1000 psi. Alloying beyond the ternary level was

necessary in order to reduce the hardness differential between the beryllium phase and the much softer matrices. When such a hardness difference exists, fracture of the matrix occurs before significant flow of the principal phase, with the result that ductility is poor. Aluminum additions to silver matrix alloys were effective in increasing the matrix hardness. A cylindrical compact of nominal matrix composition Ag-6Al-3Ge was tested in uniaxial compression. Properties were as follows: yield stress (0.2% offset) – 52,400 psi, true fracture stress – 97,000 psi, engineering fracture stress – 130,000 psi, total plastic deformation – 22%, modulus of elasticity – 22,000,000 psi, and density – 2.07 g/cc. The matrix content of this material was calculated from the density to be about 3% by volume. Its modulus-to-density ratio is 2.9 times that of steel.

AD-248948

Brush Beryllium Co., Cleveland, Ohio
DEVELOPMENT OF WROUGHT BERYLLIUM ALLOYS OF IMPROVED PROPERTIES. J. G. Klein, L. M. Perelman, and W. W. Beaver. Rept. for July 58, June 59 on Metallic Materials, Sept. 60, 113p. incl. illus. tables. (Contract AF 33(616)57-19) (WADC TR 58-478, pt. 2)

Be-rich Sn alloys, although possessing interesting room-temperature mechanical properties, are undesirable where elevated-temperature application is contemplated. Be alloys containing on the order of 3% Ni were difficult to fabricate; however, no impairment to mechanical properties was observed. Zn was undesirable as an alloy addition to Be since these alloys were difficult to fabricate and possessed poor mechanical properties as well. The addition of K improved fabricability of the difficult to fabricate Be-rich Cu alloys, but mechanical properties were not improved. Cd could not be retained in Be as an alloy, and its effect on properties could not be defined. By increasing the level of BeO content over that normally present in QMV Be, improved strength and creep properties were realized, and, in the case of hot-extruded flat bars, improved ductility was also observed, although this property was not significantly affected in other wrought forms. A possible adverse effect on impact and fatigue values by added BeO was indicated. Subsieve-size Be powder is desirable for its effect on mechanical properties if the ultra-fine grain size can be retained during hot working. Ag appears to also have an improved effect on mechanical properties if it can be retained in the grain boundaries as a uniform and continuous matrix.

AD-250097

Georgia Inst. of Tech. Engineering Experiment Station, Atlanta
INVESTIGATION OF HIGH TEMPERATURE RESISTANT MATERIALS. C. R. Mason, C. A. Murphy, and others. Summary rept. no. 4, Nov. 59 – Oct. 60, 1 v. incl. illus. tables. (Contract NOrd-15701)

Thermal Protection Systems: A technique was developed for producing wax molds without machining to be used in casting alundum heater plates. The technique involves casting a permanent silicone, rubber mold, pouring molten wax into this mold, and after cooling, peeling the rubber mold away from the wax. The heater plates checked out very well. The thermal conductivity and thermal diffusivity of 1/2- and 7/16-in.-thick slip-cast fused silica samples were determined to be 0.37 (Btu sq ft)/(hr sq ft degrees F) for each by backside tempera-

ture measurements on samples exposed to the oxyhydrogen rocket motor. Coatings: Efforts at spraying fused silica produced a thin greyish-black coating of fired silica plates that resisted color change after being subjected to an oxidizing atmosphere for 8 hr at 1600°F. Coatings of molybdenum disilicide arc-sprayed over entire Mo sheets did not form sufficient protective covering to withstand a temperature of 2200°F for 4 hr in an oxidizing atmosphere. Thermets: An x-ray analysis was made on a thermet containing 65% of beryllium-chromic oxide thermite and 35% of beryllia to determine the various components or compounds found in an ignited sample.

AD-250894
Materials Advisory Board, National Research Council, Washington, D. C.
REPORT OF THE AD HOC COMMITTEE ON REFRACTORY INORGANIC NONMETALLIC STRUCTURAL MATERIALS OF THE MATERIALS ADVISORY BOARD. Jan. 61, 1 v. incl. illus. tables. (Rept. no. MAB-169-M) (Contract DA 36-039-sc-76436)

A study was made of refractory nonmetallic inorganic materials to identify those with a demonstrated capability for high temperature structural applications and those that indicate a potential. On the basis of this study, research and development is recommended to establish the capabilities of borides and beryllides, graphite, carbides, nitrides, silicides, oxides and composite materials. It is further recommended that studies be continued in design techniques to permit the use of brittle materials in primary structures.

AD-255795
Science and Tech. Section, Air Information Div., Washington, D. C.
HIGH VOLTAGE PHOTOSENSITIVE THIN FILMS.

Analysis of CdTe films obtained by alloying components and adding arsenic impurity to determine the dependence of output voltage on process factors including thickness and base temperature. Determination of the resistivity and photoelectromotive force of binary and ternary chalcogenides of Sb and Be.

AD-258089
Armour Research Foundation, Chicago, Ill.
DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES.
F. A. Crossley

AD-263678
Armour Research Foundation, Chicago, Ill.
DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES.
F. A. Crossley

AD-264988
Electro-Optical Systems, Inc., Pasadena, Calif.
INVESTIGATION OF THE EFFECT OF ULTRA RAPID QUENCHING ON METALLIC SYSTEMS INCLUDING BERYLLIUM ALLOYS.
C. B. Jordan. Progress rept. no. 2, June – Sept. 1961, Oct. 1961, 13p. (EOS rept. 1650-4M-2) (Contract AF 33 (616) 8011, Proj. 1 (8-7351)

AD-265625

Brush Beryllium Co., Cleveland, Ohio
INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. REPT. FOR MAY 1, 1959 - OCT. 31, 1960 ON CERAMIC AND CERMET MATERIALS DEVELOPMENT. J. Booker, R. M. Paine, and A. J. Stonehouse. April 1961, 133 p. (Contract AF 33(616)6540, Proj. 7350)(WADD TR 60-889)

AD-266343

Battelle Memorial Inst., Columbus, Ohio
INVESTIGATION OF FATIGUE BEHAVIOR OF CERTAIN ALLOYS IN THE TEMPERATURE RANGE ROOM TEMPERATURE TO -423 F. REPT. FOR FEB. 1, 1960 - MAR. 15, 1961 ON METALLIC MATERIALS. R. J. Favor, D. N. Gideon, and others. June 61, 116p. (Contract AF 33(616)6888)(WADD TR 61-132)

Testing of Al, Be, Cu, Cr, Co, Fe, Ni, and Zn alloys, brass, stainless steel. Ti and V alloys applied in cryogenic missile systems, for fatigue properties as related to temperature.

AD-266424

Armour Research Foundation, Chicago, Ill.
DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES. BIMONTHLY REPT. NO. 5, SEPT. 18 - NOV. 17, 1961. F. A. Crossley and R. J. Van Thyne. Nov. 17, 1961, 3p. (Rept. no. ARF 2212-5) (Contract NOw 61-0370-c)

AD-270977

Electro-Optical Systems, Inc., Pasadena, Calif.
INVESTIGATION OF THE EFFECT OF ULTRA-RAPID QUENCHING ON METALLIC SYSTEMS, INCLUDING BERYLLIUM ALLOYS. MONTHLY PROGRESS REPT. NO. 6, FOR AUG. 1961. C. B. Jordan. Sept. 15, 1961, 3 p. (EOS rept. no. 1650-M-6) Contract AF 33(616)8011, Proj. 1(8-7351)

X-ray diffraction study of heat treated Be-Ni alloys containing 5, 7, 40, and 58 wt % Be and of Be-Al alloys containing 1.5 and 20 wt % Be.

ANL-6339

Stanford Research Inst., Menlo Park, Calif.
HIGH PURITY URANIUM COMPOUNDS. FINAL REPORT. H. J. Eding and E. M. Carr.

Preparation techniques for UAl_2, UAl_3, UAl_4, UBe_{13}, UB_2, UB_4, UB_{12}, UC, UC_2, UN, UN_2, USe, USe_2, USi_2, USi3 in alpha and beta phase, US and US_2 at 1200°C including solid-solid and solid reaction.

ANP-65 (Del.)

Oak Ridge National Lab., Tenn.
AIRCRAFT NUCLEAR PROPULSION PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 10, 1951. W. B. Cottrell, ed. Sept. 13, 1951. Decl. with deletions Nov. 16, 1959, 181p. Contract W-7405-eng-26

The design status of the ARE is summarized briefly. Extensive calculations of reflector effects with the 3-ft ARE core for several reflector compositions and thicknesses are presented. The calculated reactivity of the first experimental Be-U critical assembly is 0.90 for a configuration which actually was just critical, i.e., a reactivity of

1.00. Static-corrosion tests for 100 hr at 800°C on types 304, 316, 321, and 316 stainless steel and Inconel by the outgassed NaF-BeF-UF_4 fuel mixture resulted in average depths of attack of 2.5, 1.5, 1.0, 2.0, and 5.0 mils, respectively. Thermal capacities were determined for Zr, nickel A, and stainless steel. The thermal conductivities of Fe and Al were measured. An electronic welding technique was developed for the semi-automatic welding of small-diameter tubing. The creep rate of 347 stainless steel under irradiation was 25% lower than that of a similar but unirradiated creep specimen. The temperature contours of the ternary fluoride systems NaF-BeF_2-UF_4, NaF-KF-UF_4, NaF-RbF-UF_4, RbF-BeF_2-UF_4, and NaF-PbF_2-UF_4 were determined.

ARF-2187-3

Armour Research Foundation, Illinois Inst. of Tech., Chicago
DUCTILE BERYLLIUM ALLOYS. BIMONTHLY REPORT NO. 3 FOR PERIOD JANUARY 1 TO FEBRUARY 29, 1960. F. A. Crossley and R. J. Van Thyne. March 15, 1960, 9p. Contract NOas 60-6036-c

An envelope type microstructure prepared by liquid-phase sintering is being investigated as a means of producing ductile beryllium alloys. Results for seven new compacts are reported. A germanium addition was found to be highly beneficial to a silver-matrix compact as well as for aluminum-matrix compacts. A Be-65 Ag-1 Ge (75 vol. % beryllium) compact was reduced 70% by cold pressing. The microhardness of beryllium particles in several highly plastic compacts was found to be from 90 to 150 higher in DPH values than for relatively low-plasticity compacts. Plastic deformation decreased the apparent hardness of the "hard" beryllium grains.

ARF-2187-4

Armour Research Foundation, Illinois Inst. of Tech., Chicago
DUCTILE BERYLLIUM ALLOYS. F. A. Crossley and R. J. Van Thyne. May 18, 1960.

ARF-2187-5

Armour Research Foundation, Illinois Inst. of Tech., Chicago
DUCTILE BERYLLIUM ALLOYS. BIMONTHLY REPORT NO. 5. F. A. Crossley and R. J. Van Thyne. July 20, 1960, 15p. Contract NOas 60-6036-c (AD-240614)

An envelope type microstructure prepared by liquid-phase sintering is being investigated as a means of producing ductile beryllium alloys. Sinterability has been demonstrated previously for 25 vol. % matrix alloys of the Be-Al-Ge and Be-Ag-Ge systems, so efforts were directed toward developing alloys of lower matrix content. Previous work has given considerable evidence that matching hardness of the matrix with the principal phase is mandatory for high ductility compacts. Accordingly, quaternary additions for strengthening the matrix were investigated. The most promising alloy system is Be-Ag-Al-Ge. The hardening reaction in the silver-rich matrix of this alloy system is a peritectoid reaction $\alpha + \gamma \rightarrow \beta$. Slow cooling from above the peritectoid reaction temperature of 390°C, or quenching from above this temperature and aging below it, results in hardnesses up to three times higher than those achievable in the Ag-7.5 wt % Cu age hardening alloy. Alloys of Be-Ag-Al-Ge systems nominally containing 10 and 15 vol. % matrix were liquid-phase sintered under pressure to eliminate voids. Pressure sintering apparently squeezed out some of the matrix so that the

resulting compacts contained less than 10 vol. % matrix and probably about 5 vol. %. The compacts were very tough. This was especially evident in abrasion cutting. Two compacts were cold reduced 60% although cracking initiated at 18% reduction. These alloys are standouts among those investigated to date. They show real promise.

ARF-2187-6

Armour Research Foundation, Illinois Inst. of Tech., Chicago
DUCTILE BERYLLIUM ALLOYS. FINAL REPORT, SEPTEMBER 1, 1959 - AUGUST 31, 1960. F. A. Crossley and R. J. Van Thyne. October 20, 1960. Contract NOas-60-6036-c. 46p.

An envelope type microstructure, prepared by liquid-phase sintering was investigated as a means of producing ductile beryllium alloys. Ternary additions to Ca, Ce, Ge, La, Li, and Y were made to aluminum and silver matrix alloys to evaluate their effect in promoting sinterability. Germanium was effective in producing desirable two-phase structures. Macroporosity was eliminated in compacts containing 15% or less volume of matrix by sintering under a pressure of 1000 psi. Alloying beyond the ternary level was necessary in order to reduce the hardness differential between the beryllium phase and the much softer matrices. When such a hardness difference exists, fracture of the matrix occurs before significant flow of the principal phase, with the result that ductility is poor. Aluminum additions to silver matrix alloys were effective in increasing the matrix hardness. A cylindrical compact of nominal matrix composition Ag-6Al-3Ge was tested in uniaxial compression. Properties were as follows: yield stress (0.2% offset), 52,400 psi; true fracture stress, 97,000 psi; engineering fracture stress, 130,000 psi; total plastic deformation, 22%; modulus of elasticity, 22×10^6 psi; and density, 2.07 g/cc. The matrix content of this material was calculated from the density to be about 3% by volume. Its modulus-to-density ratio is 2.9 times that of steel.

ASD-TR-61-322

Aeronautical Systems Div., Wright-Patterson AFB, Ohio
CERAMICS AND INTERMETALLICS. J. D. Latva. p. 679-709.

Fabrication of ceramic and intermetallic structural and non-structural aerospace components from borides, beryllides, carbides, nitrides, silicides, and oxides. Effects of microstructure on brittle behavior.

CEA-tr-X-256

PROCEDURE FOR OBTAINING DIRECTLY BERYLLIUM ALLOYS OF CONCENTRATION GREATER THAN 25% BERYLLIUM USING ANY MISCIBLE METAL, INCLUDING PURE BERYLLIUM. Translated by L. Roulet from Italian Industrial Patent 349,185. Addition to Patent 342,591. June 9, 1937, 10p.

DC-59-9-53

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
INVESTIGATION OF TWO INTERMETALLIC COMPOUNDS IN THE RHENIUM-BERYLLIUM SYSTEM - $ReBe_{16}$ AND $ReBe_2$. G. C. Huth and J. P. Smith. August 25, 1959, 8p. Contract AT (11-1)-171

DC-60-4-80
General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
COMPILATION OF PROPERTIES OF BERYLLIUM INTERMETALLIC COMPOUNDS. G. C. Huth and J. P. Smith. April 11, 1960, 15p. (Contract AT(11-1)-171

Thermal and mechanical properties of Be intermetallic compounds.

LMSC-6-90-61-75
Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif.
THE ELECTROLYTIC POLARIZATION OF BERYLLIUM. TECHNICAL REPORT. D. J. Levy. Nov. 1961, 14p.

NAA-SR-5591
Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.
KINETICS OF HOT PRESSING. J. D. McClelland. Jan. 1, 1961, 21p.
Contract AT-11-1-GEN-8

Hot pressing of powdered materials can be described adequately by using a plastic flow theory proposed by Mackenzie and Shuttleworth for sintering. The present derivation assumes that the principal driving force for the closing of pores is the applied hydrostatic pressure instead of the surface tension of the pores. This pressure term, when corrected for the density of the compact, can be substituted for the surface tension term in the original derivation. The resultant equations give the material densification rate in terms of a yield point and a viscosity. The equations predict that an end-point density dependent upon the applied pressure and the yield point of the material will be reached. The effect of temperature and pressure on the rate of beryllia powder compacts was obtained experimentally. The pressures ranged from 1000 to 2000 psi, the temperatures from 1200 to 1700°C, and the time from 15 to 240 min. The curves show a steep initial rate of densification followed by a gradual approach to a nearly asymptotic end-point density. The theoretical equations are found to describe successfully the densification rates observed in beryllia when reasonable values of the yield point and viscosity are assumed.

NAA-SR-Memo-5933
Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.
BERYLLIUM AND ZIRCONIUM ALLOYS FOR GB-SR COOLANT TUBE APPLICATION. R. A. Harlow and R. K. Wagner. Dec. 1, 1960.

NBS-6645
National Bureau of Standards, Washington, D.C.
PRELIMINARY REPORT ON THE THERMODYNAMIC PROPERTIES OF SELECTED LIGHT-ELEMENT COMPOUNDS (SUPPLEMENT TO NBS REPORTS 6297 AND 6484. THIRD TECHNICAL SUMMARY REPORT TO THE ADVANCED RESEARCH PROJECTS AGENCY ON THE THERMODYNAMIC PROPERTIES OF LIGHT-ELEMENT COMPOUNDS. Jan. 1960. Amended Apr. 1, 1960, 95p.

Previously published data on the thermodynamic properties of nitrides and carbides of Li, Be, Mg, Al, and Ti are reviewed. Entropies and high-temperature heat capacities were estimated. Data on the thermodynamic properties of graphite, solid and liquid Ti, and N gas are reviewed. Heats of formation are reported for the perchlorates of

NH_4, Li, and K. Data on the vapor pressure and degree of dissociation of $AlH_3 \cdot 2N(CH_3)_2$ are given. Studies on the reactions of NH_3 with the hydrides of Al and Be are reviewed.

NEPA-1425

Fairchild Engine and Airplane Corp., NEPA Div., Oak Ridge, Tenn.
PROGRESS IN THE DEVELOPMENT OF CERAMIC GLAZE COATINGS FOR BERYLLIUM CARBIDE UNDERBODIES. Murray A. Schwartz and W. J. O'Leary. April 15, 1950. Decl. July 18, 1961, 18p. Contract (W-33-08-ac-14801(16250)

NMI-1216 (p.49-55)

Nuclear Metals, Inc., Concord, Mass.
HIGH-TEMPERATURE MODERATOR AND FUELS. J. P. Pemsler.

Various methods of fabricating sound metallic specimens of UBe_{13} and $ZrBe_{13}$ are explored, and the steam corrosion resistance testing of these intermetallics is discussed.

NMI-1216 (p.56-65)

Nuclear Metals, Inc., Concord, Mass.
BETA-BERYLLIUM PHASE ALLOY PROGRAM. S. H. Gelles.

A program to investigate various beryllium alloy systems in the hope of finding one which will stabilize the high-temperature β phase to room temperature or to a temperature low enough to retain the β phase to room temperature by quenching is summarized.

NMI-1218

Nuclear Metals, Inc., Concord, Mass.
STABILITY OF THE HIGH TEMPERATURE BETA PHASE IN BERYLLIUM AND BERYLLIUM ALLOYS. S. H. Gelles and J. J. Pickett. October 10, 1960, 44p. Contract AT(30-1)-1565

Binary alloys of beryllium with cerium, chromium, copper, iron, lanthanum, nickel, niobium, palladium, platinum, silicon, silver, vanadium, and zirconium and the ternary system beryllium-nickel-palladium were investigated by differential thermal analyses. As a result of this investigation, the beryllium-rich portion of the beryllium-nickel phase diagram was established. Tentative phase diagrams of the beryllium-rich portions of the chromium-iron-silver- and silicon-beryllium alloys are presented. Of all the elements investigated, nickel appears to have the greatest stabilizing effect on this body-centered cubic phase. The transformation temperature from β to α was found to decrease in this system from 1265°C for pure beryllium to 1065°C for Be-8 at.% Ni alloy. The latter alloy was used for investigation of the crystal structure of the high temperature phase. This was found to have a body-centered cubic lattice, the alloy having a lattice parameter $a_0 = 2.60$ Å. Some work was done in attempting to retain the β phase in a Be-8 at.% Ni alloy by quenching.

NMI-1236

Nuclear Metals, Inc., Concord, Mass.
FABRICATION DEVELOPMENT OF BERYLLIUM-CLAD URANIUM-3.8% SILICON, URANIUM-10% MOLYBDENUM, AND URANIUM-URANIUM MONOCARBIDE CERMETS. J. Greenspan. Aug. 30, 1960. 71p. Contract AT(30-1)-1565

Results of extrusion and roll cladding of U-Si, U-Mo, and U-UC cermets with beryllium are presented. Data are tabulated, and various diagrams and photographs of equipment and products are included.

NMI-1240

Nuclear Metals, Inc., Concord, Mass.
MECHANICAL PROPERTIES AND PHASE RELATIONSHIPS IN SEVERAL BERYLLIUM BINARY ALLOYS [FOR] JULY 1, 1958-JUNE 30, 1959. F. M. Yans. Sept. 8, 1960, 41p. Contract AT(30-1)-1565.

Attempts were made to fabricate Be-Zn alloys (maximum zinc content approximately 1 wt. %) by powder-metallurgy techniques. Free zinc was detected in the microstructure after solutionizing at temperatures up to 1100°C. No Be-Zn intermetallic compounds were detected. Dezincification of the beryllium alloy did not become serious until about 700°C. No solid solubility of zinc in beryllium was noted, since the beryllium lattice parameter remained unchanged by zinc addition and/or solutionizing heat treatments. The tensile properties of these alloys were at best erratic and generally poorer than those of pure beryllium.

NMI-1252

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY: STABILITY OF THE HIGH TEMPERATURE BETA PHASE IN BERYLLIUM AND BERYLLIUM ALLOYS. FINAL TECHNICAL REPORT, JULY 1, 1960 THROUGH JUNE 30, 1961. J. J. Pickett, E. D. Levine, and W. B. Nowak. Sept. 11, 1961, 34 p.

NMI-2075

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR FEBRUARY 1959. Mar. 30, 1959. Decl. Sept. 1, 1960, 38p.

Beryllium Metallurgy. The mechanical properties of extruded beryllium-clad U-Zr alloy rods were investigated. Twenty billets of hot-pressed -200 mesh QMV beryllium powder clad in mild steel have been prepared. They will be deformed by rolling at various reductions and temperatures to obtain a random orientation. Beryllium-rich copper alloys have been extruded at a reduction in area of 12:1 at 1950°F and then transverse-rolled at a reduction of 5:1 at 1850°F to form 0.100-in. thick sheet. An attempt was made to fabricate UBe_{13}, $ZrBe_{13}$, and $(U, Zr)Be_{13}$ by extruding the blended metal powders. Uranium Metallurgy. X-ray diffraction studies were made of the triple β-quenched uranium used as the starting material for extrusions, and of the uranium extruded from it at 485°C. Two attempts at extrusion of the Zr-7% Sn-1.5% Al alloy have failed. The casting of Th-U alloys in graphite molds is reported. Thorium Metallurgy. Thorium alloys are being tested in high-temperature water for the purpose of determining the most corrosion resistant alloy. Zirconium Metallurgy. Corrosion testing of the 12 zirconium base alloys in 900 and 1000°F at 1500 psi is continuing. Other Problems. A study of the shift in the extrusion of tubular aluminum billets is presented. Experiments were conducted to determine recovery and recrystallization temperatures for cold worked yttrium. The extrusion and drawing of yttrium alloy ingots into small tubing is reported.

NMI-2077

Nuclear Metals, Inc., Concord, Mass.

FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR APRIL 1959. June 12, 1959. Decl. Sept. 1, 1960, 31p.

In beryllium metallurgy, x-ray pure UBe_{13} and $ZrBe_{13}$ were prepared by sintering powder mixtures of uranium and beryllium and zirconium and beryllium at 1400 to 1500°C in an argon atmosphere. The intermetallics were then ground and hot pressed at 4500 psi. $ZrBe_{13}$ machined well; however, UBe_{13} pressing is still being evaluated. Alloys prepared for diffusion couples included Be-10 at.% Cu Be-2 at.% Fe, and Be-5 at.% Co. In uranium metallurgy, grain size and texture were evaluated for a graphite cast uranium billet (UK-144) containing 990 to 995 ppm silicon. Microstructure and texture examinations are reported and the texture after γ extrusion is being examined along with grain size. An evaluation was also made of various mold washes for casting Th-U slugs. Four slugs were cast from melt TX-163; these proved to be homogeneous from top to bottom within 0.1%. The ingots made thus far by arc melting indicate that uranium segregation is a problem. Data relating the wt % zirconium to corrosion rate are reported for uranium interdiffusion specimens in high-temperature water. Electron probe analysis of the interdiffusion zone was initiated. In cold working of uranium, a method was developed for cold drawing by a preliminary oxidizing technique and an annealing treatment. Techniques for electron-beam welding of end caps to coextruded 2S aluminum-clad uranium fuel tubes are being investigated. Weld cracking is a major problem and may be caused by a stress concentration at the root of the weld bead. To study this several caps were machined with an undercut and are being examined. A program for future development of UC rods is outlined, and a summary of ANL-TREAT diffusion couple information concerning solid-solid uranium interactions with other metals is tabulated. Research is reported in development of a thermite system for ANL-TREAT, and results of thermodynamic calculations are presented for several systems involving beryllium. Samples from four new thorium alloy castings that were Zircaloy-2 extrusion-clad were heat treated at 800 to 850°C for banding studies. Samples of bare-end extrusion-clad alloys were also corrosion tested in 500°F water; results are tabulated. Results of extrusion-clad defected-element water corrosion tests are reported as well as results from band strength tests on coextrusion. Zircaloy-2-clad thorium alloys. In zirconium metallurgy, corrosion testing of 12 ternary zirconium-base alloys in 900 and 1000°F steam is continuing. Results of corrosion testing to date are tabulated. Oxidation experiments to determine the feasibility of hot-working unclad yttrium were conducted; however, the method was not considered desirable because of oxygen gettering. Cold swaging of yttrium is being investigated, and experience in drawing thin-wall tubing is reported. Optimum extrusion temperatures are reported for a series of stainless-steel-clad uranium billets.

NMI-2078

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR MAY 1959. July 13, 1959. Decl. Sept. 1, 1960, 41p.

Beryllium Metallurgy. Results of chemical analysis of O_2 in beryllium are reported. Diffusion couples were prepared for the analysis of the β beryllium phase boundaries in the alloy systems Be-Cu, Be-Fe, Be-Co, and Be-Nb. Uranium Metallurgy. Gamma and β extrusions were made from the uranium-silicon system for the comparison of textures. An investigation to develop and evaluate arc-melting procedures for producing sound homogeneous thorium-uranium ingots is presented. A program to study the effect of an interdiffusion heat treatment and of subsequent heat treatments upon the corrosion behavior of Zircaloy-2-clad uranium-zirconium specimens containing 7-mil diameter defects extending into the core is reported. A program is presented for cold and warm working of uranium for finishing tube and wire. The apparatus for centrifuging molten uranium within a solid zirconium cladding was put into operation. Work is continuing to develop techniques for making electron beam-welded aluminum end closures on 25 aluminum-clad uranium core fuel tube irradiation samples. The development of procedures for producing sound dense UC rod materials is reported. Thorium Metallurgy. Data are presented on the effect of water temperature on corrosion rate of thorium alloys. Other Problems. Methods of fabricating semi-finished shapes from arc-melted Y billets were investigated. Work was continued on the multi-temperature extrusion process.

NMI-2081

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR NOVEMBER 1959. May 6, 1960, 31p. Contract AT(30-1)-1565

Further work with U-10 wt % Mo alloys is reported in which two roll-clad strips completely encased in beryllium were produced without visible cracks. Data indicate that cracking in the cladding is a result of expansion incompatibility. Experimental work in introduction of krypton into uranium by glow discharge was initiated. Data resulting from examination of 18 uranium base alloys by metallographic and x-ray techniques for beta phase after various heat treatments are tabulated. Thermal analysis of binary beryllium alloys such as Be-Cu, Be-V, Be-Fe, and Be-Ni are reported. Analysis of results obtained from tensile testing of rod fabricated from -200 mesh Brush QMV beryllium was completed. Work on preparing single crystals for tensile testing was continued. Work on isotopic interchange in fuels was initiated and calculated data on U isotope diffusion in $U\text{-}UO_2$ at 1000°C are tabulated. (For preceding period see NMI-2080.)

NMI-2082

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR DECEMBER 1959. May 6, 1960, 28p. Contract AT(30-1)-1565

A charge of U metal and UC_2 pebbles was heated to about 2200°C twice to obtain homogenization, and extruded. A two-phase system re-

sulted in which the dispersed particles were assumed to be UC. The density of the material was 15.785 g/cm^3 and observed particles were 100 to 200 microns. Other tests indicate that dispersion hardening in such alloys appears possible. Efforts to introduce krypton into uranium by the glow-discharge technique were continued. Data from completed tests are tabulated and design of the hollow cathode electrode which was used is described. The beta phase stability of various compositions of Cr-U, Cr-Nb-U, Cr-U-V, and Cr-Fe-Si-U, and Fe-Si-U in which the additives to U were less than 1/2% each were investigated. Thermal analyses of Be-Ni, Be-Ag, and Be-Pd were conducted. The extent of isotopic interchange in U-UO_2, and U-UC systems is being investigated. Calculated losses of U^{235} in thermal diffusion are tabulated. Work on deformation of UO_2 crystals included a test in which a single crystal was deformed at 1500°C to a total strain of about 0.2%. The surface of this crystal showed evidence of deformation by slip and kinking. (For preceding period see NMI-2081.)

NMI-2085

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR MARCH 1960. June 13, 1960, 39p. Contract AT(30-1)-1565

In the development of Be-clad U research was performed on the following: roll cladding of U-UC with Be, dimensional stability of U-UC cermet, induction melting of U-UC ingot, and extrusion cladding of epsilon U with Be. A total of sixteen vacuum-fusion samples were prepared from the cylindrical stacks and disks of the glow-discharge samples. A summary of the vacuum-fusion runs is given. Studies were made on the stability of the beta phase in U-0.3 wt % Cr-0.3 wt % Mo alloy and the determination of transformation kinetics of the U-0.3 wt % Cr alloy by measuring changes in electrical resistance during isothermal transformation of the beta phase at temperatures between 400 and 500°C. The preparation and thermal analysis are reported for Be-Pd, Be-Pt, Be-V, and Be-Ni-Pd alloys. Aging, metallographic, and x-ray data were obtained on selected samples of Be. Work is continuing to determine the order of magnitude of the isotopic interchange which would occur in dispersion-type fuel elements having a matrix of fertile material. Two crystals of UO_2 deformed in compression at ~800°C showed strong evidence of [100] slip from analysis of the observed deformation traces. (For preceding period see NMI-2084.)

NMI-2086

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR APRIL 1960. June 15, 1960, 33p. Contract AT(30-1)-1565

In the Be-clad U program investigations were continued on the extrusion cladding of U-10 wt % Mo dimensional stability on thermal cycling of extrusion clad rods and melting of U-UC. Gas analysis for the glow-discharge samples is summarized. In the program to develop metastable beta-phase U-base alloys, emphasis was placed upon a study of the transformation of the retained beta phase during isothermal annealing in the temperature range 400 to 500°C. The preparation and thermal analysis of Be-Ce, Be-Cr, and Be-La alloys are reported.

Values of the diffusion coefficient of U in UO_2 were calculated for two sets of experimental data in which the surface alpha counting rate was measured as a function of distance on a disc of natural UO_2 which had been heated in contact with molten enriched U at 1200°C. Three UO_2 crystals were polished, deformed, and analyzed. (For preceding period, see NMI-2085.)

NMI-2087

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR JULY 1960. Aug. 31, 1960, 21p. Contract AT(30-1)-1565

The adaptation of the honeycomb and dimpled-sheet techniques to the production of clad fuel elements is reported. Heat-treatment studies on alloys of Be with Fe, Cr, Pd, and Nb were initiated. Thermal analysis work was started on the Be-Co and Be-Mn alloy systems, and additional work was done on the Be-La system. Water quenching of pure Be and a Be-8 at.% Ni alloy from the liquid phase was tried, but no beta retention was observed. A program to study the mechanical properties of beta-phase Be-Ni alloys has begun. A number of fabrication techniques are being investigated for the fabrication of ThO_2-UO_2 fuel elements. An investigation into the mechanism of the corrosion of Zr alloys in high-temperature steam with emphasis on the role of intermetallic precipitates in the mechanism is reported.

NMI-2088

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR AUGUST 1960. Sept. 30, 1960, 27p. Contract AT(30-1)-1565

Progress is reported on the development of the hot-extrusion technique for UO_2. The primary object was to improve the technique sufficiently to permit fabrication of enriched fuel for irradiation. Preliminary forming studies are in process to determine the feasibility of making dimpled sheet and/or honeycomb type fuel elements. A program is reported to investigate fabrication methods for yttrium metal which will lead to improved products quality and to significant cost reductions in the fabrication of hardware. The collection and assessment of information pertinent to the design of a plant to fabricate ThO_2 fuel elements containing up to 5% U^{233} is continuing in the three categories: plant input, fuel fabrication, and plant output. The behavior of β-phase uranium during neutron irradiation under conditions that would cause gross swelling in α uranium is being evaluated. Work was begun on plans for the construction of the necessary modifications to the 100-ton vertical extrusion press to allow the extrusion of beryllium from a container filled with molten lead at 900°F. The extrusion press ram will apply force to the lead. The force will be transmitted hydrostatically to the beryllium and cause the beryllium to extrude. The billet will be designed in such a manner as to cause a progressively increasing reduction ratio as the billet extrudes. An investigation into the mechanism of the corrosion of zirconium alloys in high-temperature steam, with emphasis on the role of intermetallic precipitates, is reported. Alloys of Be-Co and Be-Mn were examined by thermal analysis. Preparation of a billet of beryllium-8 at.% nickel for hot extrusion was begun. (For preceding period, see NMI-2087.)

NMI-2089

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR SEPTEMBER 1960.
Oct. 21, 1960, 28p. Contract AT(30-1)-1565

Progress during the month on hot-extrusion techniques for UO_2 is described along with research on fabrication of nuclear fuel elements in thin gage sheets. In other areas, a program to develop economical fabrication procedures, will lead to improved product quality, is outlined. One unenriched uranium-0.3 wt % chromium and three 10% U^{235}-enriched castings were produced along with a uranium-0.3 wt % chromium-0.3 wt % molybdenum billet. These billets were extruded and sliced into samples for study. Results of metallographic examinations of these castings revealed that both the unenriched and enriched binary alloys were completely α, whereas the enriched ternary alloy was all β. Results on fabrication of billets, dies, and rams for the hydrostatic extrusion of beryllium in molten lead at 900°F revealed problem areas, which are being investigated. A program of research into the mechanism of zirconium corrosion in steam is outlined. In beryllium research preparation and thermal analysis of binary beryllium alloys was continued. Data on β-phase alloys are included along with phase study information on these alloys.

NMI-2090

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR OCTOBER 1960, 32p.
Contract AT(30-1)-1565

In the hot extrusion program only fabrication of the enriched irradiation samples and selection of the irradiation facility remained as objectives. Bend tests are reported on Zircaloy-c-clad U-2 wt % Zr alloy, aluminum-clad Al-26 wt % U alloys, and Zircaloy-4-clad uranium honeycomb type fuel elements. Yttrium metal was fabricated with a protective copper cladding at elevated temperatures, without a protective cladding, and at ambient temperatures. All material was taken from the 2-in.-diameter bar produced by primary extrusion of the cast ingot. The design of a fuel fabrication plant capable of handling U^{233} is in progress. The program to determine whether the retained β phase in uranium-base alloys is stabilized by neutron bombardment and whether the swelling rate of β-phase uranium is less than that of α uranium was continued. Research into the mechanism of the corrosion of zirconium alloys in high-temperature steam, with emphasis on the role of intermetallic precipitates, was continued. The preparation and thermal analysis of Be-Ce, Be-Cu, Be-La, Be-Mn, Be-Ni-Co, and Be-Fe-N; alloys are reported. Elevated temperature tensile tests on pure beryllium and a Be-8 at.% Ni alloy are in process. (For preceding period see NMI-2088.)

NMI-2091

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR NOVEMBER 1960. Dec. 27, 1960, 28p. Contract AT(30-1)-1565

Fabrication techniques were investigated for hot extruded uranium dioxide fuel specimens for irradiation in the VBWR. Honeycomb type

ribbon-candy and spiral fuel elements are discussed. The design concepts and model forming are given for the ribbon-candy fuel element. Yttrium fabrication work emphasized the rolling of extruded bar stock into sheet form. Plant designs for the fabrication of ThO_2 fuel elements containing 5% U^{233} has continued at the experimental level, and in studying processing details and discussions on plant layout and choice of equipment. The effects of neutron irradiation at relatively high α-phase temperatures on the behavior of metastable β-phase uranium-base alloys and the volume instability characteristics of these materials were investigated. The role of intermetallic precipitates in the mechanisms of zirconium alloy corrosion in high-temperature steam was studied. The preparation, β-phase boundary study, and thermal analysis of ternary and quaternary beryllium alloys was continued. High-temperature tensile tests were performed on beryllium at Be-8 at.% Ni alloys. (For preceding period, see NMI-2090.)

NMI-2092

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR DECEMBER 1960. Feb. 7, 1961, 34p. Contract AF(30-1)-1565

Hot extrusion of stainless-steel-clad UO_2 rods 40 to 44 in. long is reported. Attempts at forming spiral and ribbon candy fuel elements from plates of clad fuel material are described. A flat sheet, with dimples for spacing between spirals, was wrapped around a mandrel with moderate success. Ribbon candy configurations were forged of dimpled plate into a zig-zag shape, then the bends were continued until the sides of the vees became parallel. The technique was satisfactory. Extrusion of unclad cast yttrium from a 6.05-in. liner through a 2.015-in. die was performed, then 1.995-in. billets were reduced to 0.400 in. Studies were also made of the swaging behavior of extruded yttrium. The microstructure of the extruded material is described. Progress in U^{233} recycle processing is described. Results of metallographic examinations of metastable β-phase uranium-base alloys in various conditions prior to irradiation tests are given. Hydrostatic fabrication studies continued with attempts to extrude a copper billet in molten lead at 900°F. Data from the study of zirconium alloy corrosion include pressure-composition isotherms at 680°C for H_2 and Zr, $ZrMo_2$, Zr_2Cu, $ZrFe_2$, Zr_2Ni, $ZrCr_2$, $ZrSn_2$, ZrW_2, $ZrAl_2$, and Zr_2Fe. Beryllium research produced thermal effects data from the second cycle through the phase transformations for Be-Co-Fe-Ni, Be-Co-Ni with Mn, and Be-Ni with Cu. (For preceding period, see NMI-2091.)

NP-9424

New York State Univ. Coll. of Ceramics, Alfred
PHASE EQUILIBRIA BETWEEN B_2O_3 AND REFRACTORY OXIDES: THE SYSTEMS BeO-B_2O_3 AND ThO_2-B_2O_3. D. E. Rase. Aug. 1960, 15p. Project No. 7021. Contract AF33(616)-6545. (AD-235443)

The system BeO-B_2O_3 was found to have only one stable intermediate phase, $3BeO \cdot B_2O_3$, which melted above 1445°C. A tentative phase diagram is presented for the system B_2O_3-ThO_2. The system is characterized by extensive liquid immiscibility, the intermediate phase $B_2O_3 \cdot ThO_2$, and two eutectics. Selected interplanar spacings are reported for the stable phases in both systems. (See also AD-235443.)

NP-9531

Brush Beryllium Co., Cleveland
INVESTIGATION OF THE EFFECT OF PROCESSING VARIABLES AND FABRICATION TECHNIQUES UPON THE PROPERTIES OF INTERMETALLIC COMPOUNDS. TECHNICAL REPORT NO. 185.
R. Truesdale, B. Lympany, J. Klein, and M. Hornak. July 15, 1960.

Sintering studies are conducted on cold-pressed samples of $CbBe_{12}$, Cb_2Be_{17} and Cb_2Be_{19} to evaluate the variables of temperature, cold-compacting pressure, binder bake-out and mesh size. Hot-pressed specimens are examined for jacketing material, handling technique and preliminary upsetting procedure.

NP-9637

Brush Beryllium Co., Cleveland
INVESTIGATION OF THE EFFECTS OF PROCESSING VARIABLES AND FABRICATION TECHNIQUES UPON THE PROPERTIES OF INTERMETALLIC COMPOUNDS. TECHNICAL REPORT NO. 190-229. PROGRESS REPORT NO. 2 [for] JULY 1, 1960 TO SEPTEMBER 30, 1960. R. Truesdale, B. Lympany, J. Klein, M. Hornak, and W. W. Beaver. Oct. 15, 1960, 33p. Contract AF33(616)-7108

The optimum sintering temperatures of cold pressed $NbBe_{12}$, Nb_2Be_{17}, and Nb_2Be_{19} were established as 3050, 3090, and 3090°F, respectively. The compound Nb_2Be_{17} sintered to 97.5% of theoretical density. Sound 4 in.-square by 1 in.-thick blocks of Nb_2Be_{17} were fabricated and cut into transverse-rupture bars. A modulus of rupture strength of over 46,000 psi was measured at 2500°F. In the metallurgical phase, tungsten was found to be a suitable jacket material for the mechanical working of the niobium beryllides at 3000°F if protected from oxidation. Cera-kote, a refractory coating, sufficiently reduced tungsten oxidation for periods up to 1 hr. Two Nb_2Be_{17} specimens were upset at 2750°F and 7500 psi. An upset of 48% was achieved, causing a slight increase in density and grain size.

NP-9664

Massachusetts Inst. of Tech., Cambridge
FINAL REPORT [ON CERAMICS]. J. T. Norton. Nov. 1960, 9p. Contract Nonr 1841(24)

The solubility relationships of the monocarbides of V, Ti, Nb, Ta, and Zr were studied. The mutual solubility of Be_2C and ZrC was investigated. The solubility of pairs of carbides to systems containing three carbides was studied. The systems investigated were: TiC-VC-ZrC, TaC-VC-ZrC and NbC-VC-ZrC. A detailed study was made of the system Ti-Ta-C and in particular the isothermal section of this system at 1800°C. A study was made of the isothermal sections at 1700°C of the systems Mo-W-C and Mo-Ti-C. Investigations were made of the problem of sintering refractory carbides in the presence of liquid-metal binders.

NP-9873

Brush Beryllium Co., Cleveland
INVESTIGATION OF THE EFFECTS OF PROCESSING VARIABLES AND FABRICATION TECHNIQUES UPON THE PROPERTIES OF INTERMETALLIC COMPOUNDS. PROGRESS REPORT NO. 3, OCTOBER 1, 1960 – DECEMBER 31, 1960. TECHNICAL REPORT NO. 197-229. R. Truesdale, B. B. Lympany, E. M. Grala, R. M. Paine, and W. W. Beaver. Jan. 15, 1961, 59p. Contract AF33(616)-7108

Investigations were conducted on the fabrication techniques of cold-pressing and sintering, and plasma flame-spraying for the compounds, $NbBe_{12}$, Nb_2Be_{17}, and Nb_2Be_{19}. Several processing variables for cold-pressed and sintered compacts of the niobium beryllides were studied in an attempt to achieve properties comparable to those of hot-pressed specimens. These variables were particle size, beryllium content, sintering atmosphere, temperature, time, and specimen size in relation to sintering temperature, density, grain size, and strength. Low strengths for the materials resulted from large grain sizes caused by long sintering times, high sintering temperatures, and low partial pressures of helium. Small particle sizes allowed use of lower sintering temperatures and broader sintering ranges, and resulted in higher densities and better reproducibility for cold-pressed and sintered samples. Hot-pressed billets of the niobium beryllides were upset to 70% in eight minutes at temperatures to 3000°F and pressures to 7500 psi in a vacuum hot press. The microstructures of the samples were relatively unchanged, although a small amount of grain growth occurred. All of the samples were annealed for one-half hour after upsetting to prevent fracture on cooling to room temperature. Of the three compounds upset, Nb_2Be_{19} had the highest resistance to deformation in vacuum.

NP-10211

Brush Beryllium Co., Cleveland
INVESTIGATION OF REFRACTORY METAL BERYLLIDES AND SILICIDES AS VERY HIGH TEMPERATURE MATERIALS. J. Booker, R. M. Paine, and A. James Stonehouse. April 15, 1961.

NP-11178

Brush Beryllium Co., Cleveland
INVESTIGATION OF REFRACTORY METAL BERYLLIDES AND SILICIDES AS VERY HIGH TEMPERATURE MATERIALS. PROGRESS REPORT NO. 8 (for period) JULY 1, 1961 TO SEPTEMBER 30, 1961. J. Booker, R. M. Paine, and A. James Stonehouse. Nov. 10, 1961, 38p. Contract AF33(616)-6540

Determination of oxidation resistance, oxidation rate, vapor pressure, impact and thermal shock in Ta_2Be_{17}, WSi_2, Zr_2Be_{17}, $ZrBe_{13}$ at 2500-3000°F.

ORNL-2896

Oak Ridge National Lab., Tenn.
PHASE EQUILIBRIA IN MOLTEN SALT BREEDER REACTOR FUELS. I. THE SYSTEM $LiF-BeF_2-UF_4-ThF_4$. C. F. Weaver, R. E. Thoma, H. Insley, and H. A. Friedman. Jan. 11, 1961, 60p. Contract W-7405-eng-26

The phase equilibrium relations for the systems limiting the quaternary system $LiF-BeF_2-UF_4-ThF_4$ are described in detail, along with available information on the quaternary system itself. The implications of the extensive solid solutions in the limiting systems are discussed, and experimental information supporting the conclusions is presented. The optical properties, crystallographic properties, and x-ray diffraction patterns for the phases occurring in these systems are tabulated. Specific compositions of project interest to which references have been made in the ORNL literature are given special attention. Reference is made to literature reporting properties of these materials other than those discussed in this report.

ORNL-3124

Oak Ridge National Lab., Tenn.
INOR-8-GRAPHITE-FUSED SALT COMPATIBILITY TEST. R. C. Schulze and W. H. Cook. June 15, 1961.

Evaluation of the compatibility of graphite in a dynamic fluoride fuel medium of the system $LiF-BeF_2-UF_4$ at 1300°F, revealing no apparent corrosion or carburization.

ORO-255

Georgia Inst. of Tech., Atlanta. Engineering Experiment Station
MONTHLY LETTER REPORT NO. 15 COVERING THE PERIOD FROM JANUARY 15 TO FEBRUARY 15, 1960. J. D. Fleming. Feb. 19, 1960, 2p. Project No. B-153. Contract AT(40-1)-2483

The influence of neutron irradiation on the strength of slip-cast fused silica was investigated. The preparation of $Be-UO_2$ thermets is reported. Investigations of graphite mold release suspensions were continued.

PB-171489

U. S. Office of Technical Services
ATTEMPTED SYNTHESIS OF BERYLLIUM HYDRIDE. J. Powers. Oct. 1960, 35p.

Equipment designed to grind Be metal while subjected to heat and hydrogen pressure. Grinding action is supplied by mechanisms which provide the reaction vessels with either reciprocating vertical motion or motion in which the reactors' horizontal axis described a circle.

Patent - Britain 843,054

IMPROVEMENTS IN AND RELATING TO THE COATING OF METALLIC SURFACES. (to Pyrene Co., Ltd.). Aug. 4, 1960.

A method for covering titanium, zirconium, beryllium ....

Patent - Britain 869,629

IMPROVEMENTS IN OR RELATING TO NIOBIUM-BASE ALLOYS. (E. I. du Pont de Nemours and Co.) May 31, 1961.

Preparation and properties of oxidation resistant Cb alloys containing 1-20% Al, 1-30% Cr and a combined total of 0-35% Co, Ni, W, and Zr, 5% Be, Mn, Si, Tb and V and 0-2% B, C, Ca and Ce, which are adapted to withstand prolonged exposure at 800°C and above.

Patent - Britain 869,817

NIOBIUM-BASE ALLOYS. (E. I. du Pont de Nemours and Co.) June 7, 1961.

Preparation and properties of high strength and oxidation resistant Cb alloys containing 1-20% Al, 1-20% Fe, 0-35% Co, Ni, W and Zr, 0-5% Be, Mn, Mo, Si, Tb or V and 0-2% B, C, Ca and Ce for service under extreme high temperature conditions.

Patent - Britain 869,937

NIOBIUM-BASE ALLOYS. (E. I. du Pont de Nemours and Co.) June 7, 1961.

Preparation and properties of high strength and oxidation resistant Cb alloys containing 1-20% Mo, 1-30% Fe, Cr, Co, Ni, W and Zr, 0-5% Be, Mn, Si, Th or V and 0-2% B, C, Ca or Ce for service under extreme high temperature conditions.

Patent Canadian 615,734
ALLOYS OF BERYLLIUM WITH PLUTONIUM AND THE LIKE.
O. J. C. Runnalls (Atomic Energy of Canada, Ltd.) March 7, 1961.

Production of alloys of Be containing U, Pu, Ac, Am, Cm, Th or Ce by mixing a fluoride of one of the metals with Be and heating at 100-1350°C in vacuum to reduce the fluoride and to alloy the reduced metal.

TID-5912
Battelle Memorial Inst., Columbus, Ohio
METALLOGRAPHIC PREPARATION OF SELECTED CERAMIC MATERIALS. C. H. Brady, R. D. Buchheit, and Arnold F. Gerds. May 15, 1960, 13p. Contract W-7405-eng-92

Suggested metallographic procedures are presented as an aid in preparing a number of different types of ceramic materials for metallographic examination. General procedures for mounting and grinding of specimens are given. Specific procedures are included for specimens of graphite, carbon, uranium carbide, thorium carbide, uranium silicide, uranium dioxide, alumina, beryllia, and mixtures of hard particles in soft matrices.

TID-11045
Beryllium Corp., Reading, Penn.
PRODUCTION OF BERYLLIUM HYDROXIDE AND PREPARATION OF SINTER COMPACTS. QUARTERLY REPORT FOR JULY 1, 1960 THROUGH SEPT. 30, 1960.

TID-11295 (Suppl.)
Division of Reactor Development, AEC
NUCLEAR FUELS AND MATERIALS DEVELOPMENT (SUPPLEMENT). Feb. 1961, 52p.

Fabrication of BeO-30% ...

WADC-TR-58-478 (Pt. II)
Brush Beryllium Co., Cleveland
DEVELOPMENT OF WROUGHT BERYLLIUM ALLOYS OF IMPROVED PROPERTIES. PERIOD COVERED: JULY 1, 1958 TO JUNE 30, 1959. J. G. Klein, L. M. Perelman, and W. W. Beaver. Sept. 1, 1959, 128p. Project 7351. USAF Delivery Order 33(616)-57-19

Mechanical and physical properties are reported for extruded and/or rolled products fabricated from beryllium-rich alloys of silver, tin, cadmium, zinc, nickel, and copper, as well as beryllium fabricated from subsieve-size powder and powder of higher than normal beryllium oxide content.

UCRL-5988-T
California Univ., Livermore. Lawrence Radiation Lab.
CRYSTALLOGRAPHY OF SOME OF THE TRANSITION ELEMENT BERYLLIDES. A. Zalkin and D. E. Sands. May 24, 1960, 6p.

The crystallography was studied for all the beryllides of Cr, Hf, Mo, Nb, Ta, Ti, V, W, and Zr stable or metastable at room temperature.

UCRL-5989-T

California. Univ., Livermore. Lawrence Radiation Lab.
SOME PROPERTIES OF VANADIUM GROUP BERYLLIDES. O. H. Krikorian. May 25, 1960, 9p.

Vanadium group beryllides were prepared and studied by x-ray powder diffraction and crystallographic methods. Phase and sintering study results on tantalum and vanadium beryllides are included.

UCRL-5991-T

California. Univ., Livermore. Lawrence Radiation Lab.
PHASE DIAGRAMS OF ZIRCONIUM-BERYLLIUM AND RELATED SYSTEMS. R. G. Bedford. May 31, 1960, 7p.

Phase studies were carried out on the Be-Hf, Be-Ti, and Be-Zr systems, and tentative phase diagrams are presented. The systems containing Hf and Zr are similar, and the Be-Ti system is similar to the Be-Nb system, which is as expected.

WADD-TR-60-74 (Pt. I)

Research Chemicals, Inc., Burbank, Calif.
THE METALLURGY OF YTTRIUM AND THE RARE EARTH METALS. PART I. PHASE RELATIONSHIPS. PERIOD COVERED: OCTOBER 1958 TO OCTOBER 1959. B. Love. Jan. 20, 1960, 246p. Contract AF33(616)-5905. (AD-242706)

Partial constitutional diagrams were established for sixteen binary systems containing rare-earth metals. Erbium and yttrium form simple binary eutectic systems with titanium. No compounds are present. The transition temperature of titanium is not significantly affected. Copper, tin, and cobalt form intermetallic compounds with erbium and yttrium. The melting points of the rare earths are rapidly lowered, eutectics forming with the respective compounds. Vanadium forms extensive (and chromium forms limited) liquid immiscibility regions with erbium and yttrium. Eutectics are formed at the rare-earth end of the systems. Terminal solubilities are low in all the above systems. The system erbium-zirconium is characterized by appreciable solubility of zirconium in erbium and extensive solubility of erbium in both alpha and beta zirconium. There are no intermetallic compounds. The alpha erbium and beta zirconium solid solutions enter into a simple eutectic reaction. A high temperature peritectic reaction involving beta erbium is suggested. The system yttrium-zirconium is similar in all major respects except that the solubility limits at both ends of the system are somewhat lower. Preliminary investigation of the gadolinium-zirconium system indicated similarity in all major respects. Beryllium and ytterbium form an intermetallic compound. The terminal solubility of ytterbium in beryllium is low. No eutectic is observed at the beryllium end of the system. The results obtained suggest zirconium as a promising alloying element. Evidence was found for the purification of vanadium and beryllium when these metals were melted together with rare earths.

WCAP-1647

Westinghouse Electric Corp., Atomic Power Dept., Pittsburgh
THERMOELECTRIC NUCLEAR FUEL ELEMENT QUARTERLY PROGRESS REPORT - JULY-SEPTEMBER, 1960. G. R. Kilp,

W. P. Blankenship, R. C. Goodspeed, R. A. Markley, and P. V. Mitchell. Oct. 10, 1960, 55p. Contract AT-(30-3)-500

Seven binary and ternary uranium chalcogenides were prepared for melting in helium-filled tantalum bombs. The USTe material is to be swaged into a test device for thermoelectric measurements. Commercial purity PbTe is being processed in a graphite-steel bomb to learn if it can be used to realize substantial cost savings. Property measurement results are listed for various telluride thermoelectric materials and elements, and for various devices for irradiation evaluations. Life tests of PbTe elements have been running for 1700^+ hr. Results are analyzed for a Westinghouse Testing Reactor (WTR) irradiation test sample. Preinstrumentation techniques were developed to improve the amount and quality of information being secured from swaged elements under test. Calculations were made on thermal cascaded thermoelectric elements, and powder metallurgy dies for producing such elements were procured. Results of compatibility studies of PbTe and GeTe with various structural materials were reported. Data were obtained for the Case II thermoelectric reactor core designs. The design features high-enrichment fuel, a Be-UO_2 fuel matrix with a Cu-Fe inner electrical conductor and an aluminum outer conductor. Work began on the evaluation of a low-enrichment (Case III) design.

Y-1324

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn. ANALYTICAL METHODS IN THE BERYLLIUM PROGRAM. J. M. Googin. Dec. 13, 1960, 12p. Contract W-7405-eng-26

SECTION IV

BERYLLIUM OXIDE

Ackermann, R. J. and R. J. Thorn
VAPORIZATION OF OXIDES. Pergamon Press, New York, 1961.
Free energies of formation and vaporization are tabulated for oxides of the groups IA, IIA, IIIA, IVA, VA, VIA, IIIB, and IVB along with the oxides of Li, Be, Mg, Ca, Sr, Ba, B, Al, Y, La, Si, Ti, Zr, Hf, Th, V, Ta, Mo, W and U.

Aitken, E. A.
INITIAL SINTERING KINETICS OF BERYLLIUM OXIDE. American Ceramic Society Journal, v. 43: 627-633 (December 1960)
Shrinkage rate is studied as a function of calcining temperature, purity and water vapor content of the sintering atmosphere.

Aitken, E. A.
THE SINTERING CHARACTERISTICS OF BeO. Journal of Nuclear Materials, v. 3: 301-310 (March-April 1961)
Effect of various parameters including H_2O vapor content, MgO additives, predrying and sintering time, temperature and atmosphere, on the sintering behavior of BeO. Data are given for sinterability, density, porosity, grain growth and shape, and shrinkage for specimens sintered from 1200-1900°C in vacuum, and in hydrogen and oxygen atmospheres.

Apple, R. F. and J. C. White (Oak Ridge National Lab., Tenn.)
SEPARATION AND CALORIMETRIC DETERMINATION OF TRACE QUANTITIES OF MAGNESIUM IN HIGH-PURITY BERYLLIUM OXIDE. Talanta, v. 8: 419-25 (June 1961)

Budnikov, P. P. and A. A. Zvyagil'skii
SINTERING OF BERYLLIUM OXIDE. Ogneupory, v. 26, no. 11: 523-30 (1961)

Canina, Vittorio Garino
GLASS-FORMING OXIDES. Comptes Rendus Hebdomadaires des Sceances de l'Academie des Sciences, v. 252: 3967-3969 (May-June 1961) (French)
Based on the force of the Coulomb interaction between structural faults, tendencies towards vitrification are calculated for oxides of Al, As, B, Ba, Be, Bi, Ca, Cd, Ge, In, K, Li, Mg, Na, Cb, P, Pb, Si, Sn, Sr, Ti, V, Zn and Zr.

Carniglia, S. C.
SOME THERMAL AND MECHANICAL PROPERTIES OF DENSE BERYLLIUM OXIDE. p. 239-44 of MECHANICAL PROPERTIES OF ENGINEERING CERAMICS. Interscience Publishers, New York, 1961.
Measurements of the modulus of rupture, thermal expansion and thermal conductivity and computation of the index of thermal stress resistance for high-purity BeO. Comparison of the data with earlier measurements on beryllium oxide and with properties of aluminum oxide and stabilized zirconium oxide.

Chen, John C.
COMPARIOSN OF HEAT TRANSFER CHARACTERISTICS OF FUEL ELEMENTS IN PARTICULATE AND IN SOLID FORMS. American Nuclear Society Transactions, v. 4: 358-359 (November 1961)

Collongues, R., J. Stöcker, and M. Moser
THE STRUCTURE OF SOLID SOLUTIONS WITH ZIRCONIA BASE. p. 23-37 of HIGH TEMPERATURE CHEMISTRY. SECOND NATIONAL CONFERENCE, PARIS, NOVEMBER 28, 1957. Centre National de la Recherche Scientifique, Paris, 1959. (French)

The modifications in the structure of zirconia caused by the dissolution of metal oxides were studied. The solid solutions were prepared by coprecipitation in the amorphous state from a mixture of salt solutions of the two compounds. The oxides studied were MgO, NiO, FeO, ZnO, MnO, CdO, Al_2O_3, Mn_2O_3, V_2O_3, CaO, La_2O_3, Nd_2O_3, Sm_2O_3, Gd_2O_3, Y_2O_3, Sc_2O_3, Cr_2O_3, Fe_2O_3, B_2O_3, ThO_2, CeO_2, UO_2, ZrO_2, SnO_2, TiO_2, GeO_2, V_2O_5, MoO_3, SiO_2, BaO, SrO, and BeO. The results of the observations showed the existence of three very sharply defined regions: the region of oxides forming stable cubic solid solutions with zirconia, the region of oxides forming quadratic solid solutions with zirconia, and the region of oxides forming metastable solid solutions with zirconia. The oxides forming stable cubic solutions are characterized by having a value of the ratio V_c/V_a (the ratio of the volume of the cation to the volume of the anion) higher than the value of the ratio V_{Zr}/V_O for the zirconia and by an electronegativity of the cation lower than that of the zirconium. The oxides forming quadratic solid solutions are characterized by a value of the ratio V_c/V_a lower than the value of the ratio V_{Zr}/V_O and an electronegativity of the cation higher than that of zirconium.

Cox, John W. and P. Michael Uthe, Jr.
MECHANICAL AND AEROTHERMODYNAMIC DESIGN OF TORY IIA. Aerospace Engineering, v. 21: 8-20 (June 1962)

Crawford, J.H., Jr.
PHYSICAL METALLURGY AND SOLID STATE PHYSICS IRRADIATION EFFECTS. PT. 14. RADIATION STABILITY OF NONMETALLIC STRUCTURES. Chapter 2 from PROGRESS IN NUCLEAR ENERGY. Series 5. METALLURGY AND FUELS. VOL. 4. METALLURGY OF NUCLEAR REACTOR COMPONENTS. Pergamon Press, Inc., New York, 1961, p. 371-392.

Davidson, William L.
X-RAY DIFFRACTION METHODS AS APPLIED TO POWDERS AND METALS. Paper from PHYSICAL METHODS IN CHEMICAL ANALYSIS. Vol. 1. Academic Press, New York, 1960, p. 27-128.

Production, types and absorption of X-rays; X-ray diffraction; elements of crystal structure; formulas for interplanar spacings; X-ray diffraction technique; chemical analysis by X-ray diffraction; crystal system identification and unit cell determinations: crystallite and particle size from powder patterns; structure of long-chain organic compounds.

Deniz, V. C., S. B. D. Iyengar, and R. Ramanna
ON A TIME OF FLIGHT METHOD OF STUDYING THE VELOCITY DISTRIBUTION OF NEUTRONS FROM DIFFUSING MEDIA. Proc. Indian Acad. Sci. A., v. 45, no. 4: 205-14 (April 1957)

The theory is given for the velocity distribution of neutrons at a point outside a diffusing medium, following a burst of fast neutrons at a time such that slowing down is complete. Corrections are given for the finite area of emission of the neutrons and their anisotropic angular

distribution. Experimental results are given for two sizes of BeO stacks. These agree with the most probable neutron velocities inside the stack, as obtained from measurements of the diffusion cooling constant. The spectra show appreciable time of flight cooling.

DeSaussure, G.
A NOTE ON THE MEASUREMENT OF DIFFUSION PARAMETERS BY THE PULSED-NEUTRON SOURCE TECHNIQUE. Nuclear Science and Engineering, v. 12: 433-435 (March 1962)

Dimpel, D.
UTILIZATION OF NONFERROUS METALS IN NUCLEAR REACTOR TECHNOLOGY. Metall, v. 16: 214-218 (March 1962) (German)

Doyle, W. P.
OPTICAL ABSORPTION OF SOME OXIDES IN THE SCHUMANN ULTRA-VIOLET REGION. British Journal of Applied Physics, v. 12: 574-576 (October 1961)

Duckworth, Winston
BATTELLE MEMORIAL INSTITUTE. Ceramic Age, v. 76: 27-31 (October 1960)
Research projects at Battelle including development of glass composition having Sb_2O_3 and Sb_2S_3 additions, elimination of the use of "adherence" oxides in bonding of porcelain enamels to metals, methods of sintering of MgO, BeO, Al_2O_3 and UO_2 at 2300-2750°F and study of the effect of microstructural variation on the strength of ceramics.

Duckworth, Winston H. and Alfred Rudnick
STRENGTH OF CERAMIC MATERIALS. Battelle Technical Review, v. 10: 3-8 (March 1961)
Effect of porosity, crystal diameter and nominal stress at fracture on the frequency of fracture and modulus of rupture of MgO and BeO ceramics.

Efroimovich, Yu. E., V.M. Vinogradov, V.E. Pirojnikov, and C.K. Danishevski
USE OF FIREPROOF SLEEVES IN CONTROL OF TEMPERATURE OF THE LINING OF ARC STEELMAKING FURNACES WITH THE AID OF THERMOCOUPLES. Ogneupory, no. 4: 181-184 (1961) (Russian)
Investigation of protective sleeves for thermocouples installed in roof wall and melt of steel furnaces. Sleeves of ZrO_2, Al_2O_3, BeO, MgO, some of which were coated with magnesite or chrome-magnesite, are tested in use.

Felten, E. J.
SINTERING BEHAVIOR OF BERYLLIUM OXIDE. American Ceramic Society Journal, v. 44: 251-255 (June 1961)
Sintering characteristics of BeO in hydrogen between 1500°C and 2100°C. Effect of firing temperature and sintering time on density and grain growth. Effect of oxide additives.

Fisher, John G.
MATERIALS FOR NUCLEAR POWERPLANTS. Space/Aeronautics, v. 37: 75-79 (April 1962)

Gatzek, Leo E.
AEROSPACE MATERIALS REQUIREMENTS. Metals Engineering Quarterly, v. 2: 16-20 (February 1962)

Glaeser, W. A.
WEAR CHARACTERISTICS IN NONMETALLIC MATERIALS. Electro-Technology, v. 69: 139-145, 151 (April 1962)

Häfele, Wolf
THE FAST MULTIPLICATION EFFECT DUE TO THE (n,2n) REACTION IN BERYLLIUM AND BERYLLIUM OXIDES. p. 163-76 of PROCEEDINGS OF THE CONFERENCE ON THE PHYSICS OF BREEDING, October 19-21, 1959.

Harris, L. A., R. A. Potter, and H. L. Yakel
PRELIMINARY OBSERVATIONS OF MIXED OXIDE COMPOUNDS CONTAINING BeO. Acta Crystallographica, v. 15, no. 6: 615-616 (June 1962)

Preparation of 2 CaO-3 BeO, 2 SrO-3 BeO and Y 203-2 BeO by melting the oxides at 1300-1600°C in air and Ar. The composition is determined by chemical analysis and measurements are made of the refractive indices, crystal systems, lattice parameters, space groups, densities and pyroelectricity.

Herpin, A. and D. Saint James (Center d'Etudes Nucleaires, Saclay, France)
DIFFUSION LENGTH OF A CRYSTALLINE POWDER, AND DISTORTION OF THE MAXWELL SPECTRUM. J. phys. radium, v. 22: 193-203 (April 1961) (French)

Hon, J. F.
NUCLEAR QUADRUPOLE COUPLING CONSTANT OF Be^9 IN BeO. Physical Review, v. 124: 1368-1372 (December 1961)

Ikuye, K. K. and Gerald R. Grow
BRAZING BERYLLIUM OXIDE TO PYROLYTIC GRAPHITE. American Welding Society, 43rd Annual Meeting, April 1962, Technical Abstract.

Iyengar, S. B. D., G. S. Mani, R. Ramanna, and N. Umakanth
SLOWING DOWN AND DIFFUSION OF NEUTRONS IN BERYLLIUM OXIDE. Proc. Indian Acad. Sci. A, v. 45, no. 4: 215-23 (April 1957)

The theory is given which enables the constants of a moderator to be deduced from measurements on the decay rate of thermal neutron density, in assemblies ranging in size, following a burst of fast neutrons. Results are given for BeO using fifteen assembly sizes, and compared with earlier results for other moderators.

Iyengar, S. B. D., G. S. Mani, R. Ramanna, and N. Umakanth
TEMPERATURE DEPENDENCE OF THE SLOWING DOWN AND DIFFUSION CONSTANTS OF NEUTRONS IN BERYLLIUM OXIDE. Proc. Indian Acad. Sci. A, v. 45, no. 4: 224-30 (April 1957)

The BeO stack was heated in an electric furnace, precautions being taken to prevent escaping neutrons being reflected back into the stack. Observations were made of the decay in thermal neutron intensity following a burst of fast neutrons. Values are given for the diffusion coefficient and diffusion cooling constant at 297°, 353° and 413°K, and values of the relaxation time are deduced from them. Graphs are given for the variation of equilibrium temperature and diffusion cooling constant with stack temperature. The latter graph indicates a decrease

of the heat transfer coefficient with increasing temperature, contrary to the Debye model.

Joanou, G. D., A. J. Goodjohn, and M. F. Wikner
MOMENTS CALCULATIONS OF THE FERMI AGE IN VARIOUS MODERATORS. American Nuclear Society, Transactions, v. 4: 278-279 (November 1961)

Kjellgren, Bengt R. F.
STATUS OF THE BERYLLIUM INDUSTRY IN THE UNITED STATES OF AMERICA. Paper from SYMPOSIUM ON LIGHT METAL INDUSTRY IN INDIA. National Metallurgical Laboratory, Jamshedpur, India, 1961, p. 57-67.

Lowdin, Per-Olov
BAND THEORY, VALENCE BOND AND TIGHT-BINDING CALCULATIONS. Journal of Applied Physics — Supplement, v. 33: 251-280 (January 1962)

Martini, Otto
CHARACTERISTICS OF REFRACTORIES WITH EMPHASIS ON FOUNDRY REFRACTORIES. Giesserei-Technik, v. 6: 263-266 (September 1960) (German)

Selection of basic or acid refractories for use with various temperatures, burdens, oxidation levels of Fe and fuel. Chemical composition and physical and mechanical properties of silica and magnesite bricks, fire-clay, bauxite-sillimanite bricks, chromite bricks and pure refractory materials such as Al_2O_3, MgO, ZrO_2, ThO_2 and BeO.

Mash, Donald R.
PLASMA-ARC SPRAYING OF REFRACTORY METALS. Fansteel Metallurgy: 2-3 (June 1962)

O'Neill, J. S., A. W. Hey, and D. T. Livey
DENSITY AND PERMEABILITY RELATIONSHIPS IN FABRICATED BERYLLIA. Journal of Nuclear Material, v. 3: 125-137 (February 1961)

The permeability to various gases of fabricated beryllia of 80-95% theoretical density is measured with permeability coefficients, B_0 and K_0 being calculated from the Carman equation and gas flow through beryllia being compared with that through graphite.

Paprocki, S. J., E. S. Hodge, and P. J. Gripshover
GAS-PRESSURE BONDING. Light Metal Age, v. 19: 17, 20, 22-23 (December 1961)

Paprocki, S. J., E. S. Hodge, and P. J. Gripshover
GAS-PRESSURE BONDING. Materials in Design Engineering, v. 55: 14-15 (March 1962)

Rau, R. C.
X-RAY DIFFRACTION INVESTIGATION OF BeO CALCINATION PROCESSES. Paper from ADVANCES IN X-RAY ANALYSIS. VOL. 4. Plenum Press, New York, 1961, p. 19-39.

The hydroxide, sulphate and oxalate of Be were the starting materials in three calcination series. Analysis of the hydroxide series showed a direct conversion from $Be(OH)_2$ to BeO by simple loss of water. However, both the sulphate series and the oxalate series go through a series of intermediate phases in transforming to BeO.

Rief, Herbert
THE FAST EFFECT IN URANIUM AND BERYLLIUM SYSTEMS. Nuclear Science and Engineering, v. 10: 83-89 (May 1961)

Ryshkewitch, Eugene
METAL OXIDE CERAMICS. International Science and Technology: 54-61 (February 1962)

Sabine, T. M., A. W. Pryor, and B. S. Hickman
SCATTERING OF LONG WAVE-LENGTH NEUTRONS BY IRRADIATED BERYLLIUM OXIDE. Nature, v. 191: 1385-1386 (September 1961)

BeO is reactor irradiated and measurements are made using a neutron spectrometer with a mica monochromator and Be and BeO filters. Neutron transmission and scattering is measured as a function of annealing temperature from 200-1400°C and the effect is explained with a vacancy defect model.

Salesse, M.
METALLURGY AND ATOMIC ENERGY – DIFFICULTY AND RESULTS ACQUIRED. Nukleonik, v. 2: 79-83 (April 1960) (French)

As is known, the French atomic program is based in part on reactors cooled with gas and utilizing different moderators such as graphite, heavy water, and beryllium oxide. The tables presented survey the metallurgy situation with respect to reactors. The selection of a Mg alloy for cladding, behavior of fritted beryllium oxide under the effect of radiation and corrosive conditions, and the radiation stability of uranium under high burn-up are the topics considered.

Srinivasan, N. and G. S. Tandolkar
PROPOSED PILOT PLANT FOR PRODUCTION OF SINTERED BERYLLIUM OXIDE FROM BERYL ORE. Paper from SYMPOSIUM ON PILOT PLANTS IN METALLURGICAL RESEARCH AND DEVELOPMENT. National Metallurgical Laboratory, Jamshedpur, India, July 1960, p. 137-142.

Proposal for a pilot plant which will treat about 150 kilos of beryl ore and produce 9 kilos of brick per day. Flow charts are given for production of sintered bricks from technical grade hydroxide.

Sawamoto, Hachie, Takeo Oki, and Akira Nishina
DETERMINATION OF IMPURITIES IN BERYLLIUM OXIDE USED FOR BERYLLIUM METAL PRODUCTION. PT. 1. Faculty of Engineering-Nagoya University, Memoirs, v. 12: 269-273 (November 1960) (English)

Tawde, N. R. and N. Sreedhara Murthy (Karnatak Univ., Dharwar, India)
ELECTRONIC TRANSITION MOMENT VARIATION IN ($B^1\Sigma \rightarrow X^1\Sigma$) BANDS OF BeO. Proc. Indian Acad. Sci., Sec. A 51: 219-31 (April 1960) (English)

Accurate integrated intensity data of the bands of BeO ($B^1\Sigma \rightarrow X^1\Sigma$) system were obtained experimentally by the technique of photographic photometry. With the use of Franck-Condon factors and r-centroids for the bands available from previous work, the relation of electronic transition moment R_e with internuclear separation r, was evolved. The vibrational transition probabilities were corrected for the resulting variation of R_e with r. These corrected values were examined in relation to those under assumptions of constancy of R_e in conjunction with (i) mechanical anharmonicity and also (ii) mechanical harmonicity.

Van Perr, W. J.
THE OXIDATION OF POLYCRYSTALLINE BERYLLIUM IN CARBON DIOXIDE. Australian Journal of Physics, v. 14: 191-193 (March 1961)
Growth and structure of Be oxide on polycrystalline Be studied using weight gain versus time curves, electron diffraction and X-ray diffraction. Oxide grows with preferred orientation and estimate of crystal sizes made. Possible thermodynamic reactions given along with diffraction patterns. Be carbide formation explained.

Vratny, F. M. Dilling, F. Gugliotta and C. N. R. Rao
INFRARED SPECTRA OF METALLIC OXIDES, PHOSPHATES AND CHROMATES. Journal of Scientific & Industrial Research, v. 20B: 590-593 (December 1961)

Zhezherun, I. F. and A. A. Chernyshov
THE INFLUENCE OF TEMPERATURE ON THE SCATTERING OF THERMAL NEUTRONS ON BAKED BERYLLIUM OXIDE. Akademiya Nauk S. S. S. R. Ordena Lenina Institut Atomnoi Energii, 1960, 18p. (AEC-tr-4688)
Measurements of the total effective cross section values of sintered BeO with a mechanical selector using 0.0025-10 eV neutrons at sample temperatures of 290-1500°K.

Zhezherun, I. F., I. P. Sadikov, and A. A. Chernyshov
MEASUREMENT OF THE SLOWING DOWN LENGTH OF FISSION NEUTRONS TO 0.3 eV IN BAKED BERYLLIUM OXIDE. Akademiya Nauk S. S. S. R. Ordena Lenina Institut Atomnoi Energii, 1960, 19p. (AEC-tr-4689)
Measurement of the slowing down density from a point source of fission neutrons in sintered BeO to 0.3 eV using a Pu^{239} fission chamber.

Zhezherun, I. F., I. P. Sadikov, V. A. Taraban'ko, and A. A. Chernyshov
MEASUREMENT OF THE SLOWING DOWN LENGTH OF FISSION NEUTRONS TO 1.44 eV (INDIUM RESONANCE) IN BAKED BERYLLIUM OXIDE. Akademiya Nauk S. S. S. R. Ordena Lenina Institut Atomnoi Energii, 1960, 21p. (AEC-tr-4691)

American Institute of Mining, Metallurgical, and Petroleum Engineers, Transactions, v. 220: 420-423 (1961)
FLOTATION OF SPODUMENE-BERYL ORES.

Australian Mechanical Engineering, v. 48: 34-36 (March 1961)
EQUIPMENT INSTALLED FOR METALS RESEARCH AT LUCAS HEIGHTS.
A survey of machine tools and their applications in milling, boring, cutting, welding, rolling, extruding, forging, and melting. Be and Be_2O_3 are evaluated as materials for use in reactors.

Mines Magazine, v. 52: 7 (February 1962)
BERYLLIUM CONCENTRATES MILL OPENED IN BODGER FLATS AREA.
Concentration of Be ore to 98% pure BeO with flotation process.

Mining Engineering, v. 13: 1144-1145 (October 1961)
MINCON EMPLOYS PELLETIZER TO BENEFICIATE BERYLLIUM ORE.

National Metallurgical Laboratory, Proceedings, Council of Scientific and Industrial Research, Jamshedpur, India, 12p.
SYMPOSIUM ON PILOT PLANTS IN METALLURGICAL RESEARCH AND DEVELOPMENTS (FEBRUARY 15-18, 1960)

Plenum Press, New York, 1961, p. 40-62
CRYSTALLITE SIZE AND PARTICLE SIZE MEASUREMENTS ON BeO POWDERS BY X-RAY ANALYSIS. VOL. 4.
Measurements of the surface area, particle size and crystallite size of BeO powders prepared from different source scattering and X-ray line-broadening are compared with electron micrographs and surface area values by air permeability, nitrogen adsorption and water-vapor adsorption.

Reactor Core Materials, v. 4: 28-31 (May 1961)
NUCLEAR POISONS.
Review of current literature on equilibrium diagrams, eutectic points, corrosion and He evolution for Fe-Gd, Ni-Gd, Ti-Ir, Ag-In-Cd and Ag-In-Cd-Sn alloys and for boronated stainless steels, boral, SiC, BeO, Gd_2O_3 and Sm_2O_3.

Reactor Core Materials, v. 4: 26-27 (August 1961)
NUCLEAR POISONS.
Determination of the reactivity of B compounds dispersed in Ti, Fe, Zr, stainless steel, Ni, Cu and Al at 550-2050°C. Nuclear poisons studied includes HfB_2, TiB_2, B_4C, ZrB_2, YB_4, CuB_6, EuB_6, SmB_6 and YB_6. Solid phase studies are performed on the BeO-Sm_2O_3 and BeO-Gd_2O_3 systems at 1450-2500°C.

Steel, v. 149: 50-54 (December 1961)
NEW MATERIALS, TECHNIQUES INCREASE VERSATILITY OF CERAMICS.

AAEC/E-80
Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales
A COMPARATIVE STUDY OF TWO GRADES OF BeO. K. D. Reeve and E. J. Ramm. November 1961. 33p.
Comparison of grain size, purity, bulk density and surface area. Fabricability is determined by hot and cold pressing and sintering tests.

AD-235443
New York. State Univ. Coll. of Ceramics, Alfred
PHASE EQUILIBRIA BETWEEN B_2O_3 AND REFRACTORY OXIDES. THE SYSTEMS BeO-B_2O_3 AND ThO_2-B_2O_3. D. E. Rase. August 1960. 15p. (Project No. 7021) (Contract AF 33(616)-6545)

AD-239649
Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
AN INVESTIGATION OF THE THEORETICAL AND PRACTICAL ASPECTS OF THE THERMAL EXPANSION OF CERAMIC MATERIALS. QUARTERLY PROGRESS REPORT. Harold T. Smyth and Kenneth M. Merz. June 1960. 4p. (Rept. no. PI-1273-M-7) (Contract NOrd-18419)
Work is continuing on Turner's method for predicting the thermal expansion coefficients of mixtures of pure phases. In the MgO-MgO·Al_2O_3 system, expansion measurements are being made on a series of specimens which have been given a very slow cooling treatment in order to

minimize thermal shock. Polished sections have been prepared of some previously tested specimens in an attempt to detect microcracks which could have been responsible for their anomolous expansion behavior. However, no microcracks were observed under the microscope at 45OX. Work is also continuing in the BeO-MgO system. It has been found that if pure BeO fired at 1600°C for four hours is subjected to repeated thermal expansion measurements, the expansion coefficient increases rather rapidly. Refiring the specimen reduces the thermal expansion, but with successive measurements the expansion coefficient again increases. The study of the effect of solid solution atoms on the thermal expansion anisotropy of TiO_2 has been held up because of a breakdown of the X-ray equipment. This problem has been largely overcome, and data are now being collected on the thermal expansion anisotropy of pure rutile and rutile with solid solution substitution of W, Si, Nb and Mo.

AD-240341

Battelle Memorial Inst., Columbus, Ohio
INVESTIGATION OF SINTERABLE POWDERS AND PROPERTIES OF BERYLLIA CERAMICS. REPORT FOR FEBRUARY 15-DECEMBER 31, 1959 ON ELECTRICAL AND ELECTRONIC MATERIALS. James E. Johnson, A. K. Smalley, and Winston H. Duckworth. April 1960. 19p. (WADD TR 60-108) (Contract AF 33(616)6238)

Information was developed on the effects of processing variables and microstructure on the fracture strength of ceramics made from sinterable oxide powders. The characteristic of high strength being associated with low porosities and small average crystal sizes was observed in ceramics of both MgO and BeO, but no quantitative correlation was found. Highest strengths were obtained when the time and temperature of sintering were sufficient for densification above about 90 percent of theoretical, provided that the sintering time and temperature was insufficient to give crystal sizes larger than the smallest observed, 5-6 microns for BeO ceramics and about 10 microns for MgO ceramics. In the case of BeO powder prepared by pyrolysis of high-purity sulfate, calcining to an intermediate temperature (1700-1800°F) gave the powder that densified most readily when compacted and sintered, but one that did not have the greatest tendency toward crystal growth. Thus, this most sinterable powder produced the strongest BeO ceramic. The lack of quantitative correlations between bulk density, average crystal size, and strength, together with appreciable scatter in strength values, indicated that strength was affected by some factor or factors other than these two. Localized areas of crystal growth found in BeO specimens may have had an influence.

AERE-AM-73

United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Chatham Outstation, Kent, England
THE SPECTROGRAPHIC ANALYSIS OF BERYLLIUM METAL AND COMPOUNDS USING BARIUM HYDROXIDE-GRAPHITE MIXTURES. M. A. Lund and D. L. G. Smith. November 1960.

Beryllium oxide mixed with a diluent of barium hydroxide, graphite powder and tin oxide is charged into graphite cups and the spectrum excited in a d-c arc.

APEX-531

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
BERYLLIUM OXIDE HYDROLYSIS. M. E. Lapides, R. J. Spera, M. J. Mullikin and J. H. King. December 1956. 26p. Decl. June 1961. (Contracts AF 33(600)-38062 and AT(11-1)-171).

Summary of system equilibrium and corrosion kinetics for BeO. Assessment of consistency and engineering utility of deposition tests.

APEX-653

ASTRA, Inc., Raleigh, N. C.
HAND CALCULATION OF SPATIAL DISTRIBUTION OF NEUTRON ACTIVATION. J. T. Lence, H. R. Kroeger, Andrew Lowery, F. A. Bryan, Jr., and E. M. Page. August 1960. 34p. (Contracts AF 33(600)-38062 and AT(11-1)-171).

APEX-684

General Electric Co. Flight Propulsion Lab. Dept., Cincinnati
BASIC MATERIALS STUDIES: SINTERABLE HIGH PURITY BeO. FINAL REPORT. W. J. Kirkpatrick, G. R. Anderson, and E. S. Funston. June 1961. 45p. (Contracts AF 33(600)-38062 and AT (11-1)-171).

Beryllium basic acetate is converted to beryllium hydroxide which is calcined to form beryllia.

BMI-726 (Del.)

Battelle Memorial Inst., Columbus, Ohio
PROGRESS REPORT FOR THE MONTH OF JANUARY 1952. H. W. Russell, H. R. Nelson, and R. W. Dayton. February 1952. Decl. with deletions April 1957. 48p. (Contract W-7405-eng-92)

Studies of the effect of body variables on the resistance of sintered BeO to thermal fracture are reported. Postirradiation measurements on graphite fuel structures containing enriched U are in progress. The compound $3Nb_2O_5 \cdot ZrO_2$ was formed by sintering mixtures of the oxide powders and some strength properties were determined. High-density graphite compacts were prepared. Creep and dimensional stability studies of U are continuing. Methods of roll-cladding U and U-Cr alloys with Zr are being developed. Additional bending fatigue data on Th sheet are reported. Roll-cladding of Th with Zr, Ti, and stainless steel is being studied. Creep tests on Sn-Zr alloy are being made. Corrosion studies on Sn-Zr alloys are reported. High-temperature creep tests of 2S Al are continuing. Work is continuing on the preparation of pure metal sulfides for use as solvents for U compounds. Corrosion studies on Ni are reported.

BMI-1448 (Rev.)

Battelle Memorial Inst., Columbus, Ohio
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JUNE 1960. Russell W. Dayton and Clyde R. Tipton, Jr. July 1960. 104p.

Solid solutions of uranium oxide containing massive additions of La_2O_3 or Y_2O_3 are being investigated with respect to their stability in an oxidizing environment at higher temperatures. An investigation is being conducted on the effects of ultrahigh pressure and high temperature on the U-O system and on reactions of uranium oxides with various mixed oxides. Work was continued on the investigation of the effects of fast-neutron irradiation upon the mechanical properties of Type 347 stainless steel. Experimental work was completed in the program to

develop a corrosion resistant, high-strength, low- cross-section Nb alloy for pressurized water-reactor applications. The creep behavior of Zircaloy-2 during irradiation is to be studied by comparing the total creep deformation obtained under reactor conditions and that obtained out of reactor. Friction and wear studies in vacuum, in argon, and in sodium environments were continued for W on W specimens and for Mo on stainless steel coated Na_2MoO_4. Corrosion tests of the Nb-U alloys were continued in 600°F water with an accumulation of 336 days of exposure. Thorium-uranium and Th-U-base alloys are being investigated with the aim of improving their irradiation stability. Studies of diffusion of fission gases and of iodine in single crystals or fused UO_2 plates have continued. Methods of fabricating 60 to 90 vol. % UO_2 cermets to 90% of theoretical density or greater were investigated. Economical methods for producing useful UC components from powders are being studied. Further progress in research directed toward preparation of high-purity and high-quality single crystals of UO_2 was made. The program concerned with obtaining electrical- and thermal-conductivity measurements for UO_2 before and after irradiation was resumed. A study of the corrosion properties of welding alloys for use with Hastelloy F was completed. Data are reported on the stress-rupture strength of Al-35 wt. % U alloys. The corrosion of Ta and Ta alloys by liquid Pu alloys is being studied. Research on core materials for both the MGCR and HTGR is in progress. For the MGCR, the major effort is on development and evaluation of UO_2 dispersions in BeO and Al_2O_3 and dispersions of UC or UC_2 in graphite. For the HTGR, vapor deposition is being investigated as a method of preparing and coating UC and ThC powder. Techniques are being developed for the preparation of instrumented SM-1. Type fuel plates for in-pile test evaluation. Materials were selected, fabrication techniques developed, and specifications written for the production of SM-2 fuel plates. A study is being made of the processing variables in the fabrication of BeO-UO_2 ceramics. The study of the radiation stability of various potential ML-1 fuel material is progressing. The corrosion of Th and U under storage conditions is being investigated. An investigation of the behavior of Pu in a pyrometallurgical process developed for the recovery of U from spent fuel elements was completed.

BMI1484

Battelle Memorial Inst., Columbus, Ohio
A STUDY OF THE RADIATION STABILITY OF UO_2 DISPERSIONS IN BeO.
David G. Freas, James H. Saling, Herbert D. Sheets, John H. Stang, John E. Gates, and Ronald F. Dickerson. December 1960. 29p.
(Contract W-7405-eng-92)

An experiment was performed to determine the radiation stability of beryllium oxide fueled with approximately 56 wt. % UO_2. Pellets of BeO-UO_2 were prepared by cold-pressing techniques followed by sintering at 2800°F for 2 hr in a hydrogen atmosphere. These pellets were contained in Hastelloy-X tubes sealed by heliarc welding. Temperature measurements and burn-up analysis by isotopic techniques indicated that the specimen surface temperatures ranged from 1450 to 1725°F with burn-ups ranging from 1.5 to 2.0 at. % of the U^{235}. A specimen similar to the irradiation specimens was thermally cycled at temperatures simulating, as closely as possible, those experienced by the irradiation specimens. These fueled pellets did not show any changes in their physical properties or microstructures. The postirradiation examination of the specimens

from Capsule GCRE-BRR-II included fission-gas analyses, dimensional and density measurements, isotopic burn-up analysis, and detailed metallographic examinations of both the fueled BeO pellets and the Hastelloy-X tubes. Only negligible changes in the physical properties were detected. The visual and metallographic examinations of the fueled BeO pellets did not reveal any structural changes. An irregular ring type configuration was observed on the inner surface of the Hastelloy-X tubes. The metallographic examination of a longitudinal edge of these tubes showed ridges and recessed areas which by measurement corresponded relatively well with the configuration observed on the inner surface. These results indicate that BeO fueled with approximately 56 wt. % UO_2 dispersions withstood irradiation to 2 at. % burn-up of the U^{235} at temperatures near 1800°F without any detrimental effects.

CEA-1234

France. Commissariat A l'Énergie Atomique, Paris
MANUFACTURE OF SINTERED BRICKS OF HIGH DENSITY FROM BERYLLIUM OXIDE. R. Pointud, Ch. Rispal, and M. Le Garec.
Also published in Silicates inds. no. 2: 8 (1959) (French)

Beryllium oxide bricks of nuclear purity 100 by 100 by 50 and 100 by 100 by 100 mm of very high density (between 2.85 and 3.00) were manufactured by sintering under pressure in graphite molds at temperatures between 1750 and 1850°C, and under a pressure of 150 kg/cm^2. The physicochemical state of the saw material is of considerable importance with regard to the success of the sintering operation. In addition, a study of the sintering of a BeO mixture, with 3 to 5% of boron introduced in the form of boric acid, boron carbide, or elementary boron showed that high densities can only be obtained by sintering under pressure. For technical reasons of manufacture, only the mixture based on boron carbide was used. The sintering was carried out in graphite molds at 1500°C under 150 kg/cm^2 pressure, and bricks were obtained with density between 2.85 and 2.90. Laboratory studies and the industrial manufacture of various sinters are described in detail.

CEA -tr-R-1079

STUDY OF THE THERMODYNAMICS OF THE REACTION OF REDUCTION OF BERYLLIUM OXIDE BY CARBON. M. V. Smirnov and N. Ya. Chukreev. Translated into French by B. Vinogradoff from Zhur. Neorg. Khim., v. 3: 2445-9 (1958). 15p.

The emf of galvanic elements composed of a metallic beryllium electrode and BeO-C electrode placed in a fused equimolecular mixture of NaCl and KCl containing 1 to 3 wt % $BeCl_2$ was measured between 682 and 1040°C. From the experimental data, the variation of the isobar potential of the reaction $Be_{sol} + 0.5\ CO_2 \rightarrow BeO_{sol} + 0.5\ C_{graphite}$ was determined. From experimental and published data the standard values for the formation and entropy heats were calculated for BeO.

CF-59-8-87 (Rev.)

Oak Ridge National Lab., Tenn.
POWER DENSITY IN CERAMIC-FUEL-ELEMENT GAS-COOLED REACTORS. R.S. Carlsmith. August 1959. 16p. (Contract W-7405-eng-26)

The maximum practical power density for ceramic-fuel-element gas-cooled reactors was studied. It appears that 100 to 200 w/cm^3 is attainable with uranium bearing graphite and 50 to 100 w/cm^3 with uranium bearing BeO.

CF-60-1-43

Oak Ridge National Lab., Tenn.
NUCLEAR CHARACTERISTICS OF BeO-MODERATED CORES VS GRAPHITE-MODERATED CORES. R. S. Carlsmith. January 1960. 10p.

Multigroup calculations were performed to compare BeO-moderated cores with graphite-moderated cores, using various void fractions and core diameters. The core leakages and conversion ratios which were calculated are presented in a series of curves.

CF-61-2-3

Oak Ridge National Lab., Tenn.
PROCESSING OF BERYLLIUM OXIDE FUELS. K. S. Warren and L. M. Ferris. February 1961. 10p. (Contract W-7405-eng-26)

Preliminary results from experiments on the dissolution of beryllium metal and sintered UO_2-BeO fuel pellets are reported. Uranium, from UO_2-BeO pellets containing more than 60% UO_2, is readily leached with boiling 6 to 13$\underline{M}$ HNO_3 in ~6 hr. The BeO in these pellets dissolves only slowly in HNO_3; however, in 8$\underline{M}$ HNO_3-0.2$\underline{M}$ NaF it dissolves at about the same rate as the UO_2. Sintered pellets containing less than 10% UO_2 do not dissolve rapidly in common aqueous reagents. The highest rates are obtained in boiling acidic fluoride solutions; e.g., sintered BeO and BeO-8% UO_2 dissolved initially at a rate of ~1.7 mg/min cm^2 or 13 mils/hr in boiling 5.8$\underline{M}$ NH_4HF_2. Sintered BeO dissolved at an average rate of 5 mils/hr by bubbling HF through molten 49 mole % NaF-40 mole % LiF-11 mole % BeF_2 at 600°C.

DC-58-7-146

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
STRESS-STRAIN-TEMPERATURE-TIME RELATIONSHIPS IN REFRACTORY MATERIALS. R. D. Chipman. July 1958. 40p. (Contract AT (11-1)-171)

DC-59-12-221

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
PULSED NEUTRON MEASUREMENTS ON BERYLLIUM OXIDE. K. W. Seemann. December 1959. 15p. (Contract AT(11-1)-171)

BeO slabs are tested by the pulsed neutron technique to determine the diffusion constant and the macroscopic absorption cross section.

DCL-58-12-17

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
PREPARATION OF BERYLLIUM OXIDE. R. Cooperstein. November 1958. 10p. (Contract AT(11-1)-171)

Procedure for the production of high purity BeO.

DCL-59-8-93

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
BeO STANDARDS. R. Cooperstein. August 1959. 19p. (Contract AT (11-1)-171)

Specification of BeO for use in nuclear applications.

DMIC Memo 110

Defense Metals Information Center, Battelle Memorial Institute
GLASS FIBER FOR SOLID-PROPELLANT ROCKET-MOTOR CASES.
R. J. Runck and B. W. King. June 1961. 17p.

A study of the properties of glass fibers and their use in forming glass reinforced plastic rocket motor cases. Tensile strength, chemical, atmospheric and abrasion resistance, the effect of BeO on the modulus of elasticity, devitrification, manufacturing processes and compositions are discussed.

DMIC Memo 148

Defense Metals Information Center, Battelle Memorial Institute
EMITTANCE OF CERAMICS GRAPHITE. W. D. Wood, H. W. Deem, and C. F. Lucks. March 1962. 106p.

GA-1532

General Atomic Div., General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.
MARITIME GAS-COOLED REACTOR PROGRAM. QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1960. 146p. (Contract AT(04-3)-187)

GA-1738

General Atomic Div., General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.
MARITIME GAS-COOLED REACTOR PROGRAM. QUARTERLY PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1960. 117p. (Contract AT(04-3)-187)

GA-2262

Brush Beryllium Co., Cleveland. For General Atomic Div., General Dynamics Corp., San Diego, Calif.
MARITIME GAS-COOLED REACTOR PROGRAM. TECHNICAL FEASIBILITY STUDIES OF FABRICATION TECHNIQUES APPLICABLE TO THE MANUFACTURE OF HIGH-DENSITY BERYLLIA TUBES FOR POTENTIAL UTILIZATION IN THE MARITIME GAS-COOLED REACTOR. FINAL REPORT, MAY 9 TO JUNE 30, 1960. Chester A. Bielawski, Edward A. Douglas, and John G. Theodore. 50p. (Contract AT(04-3)-187)

GAMD-974

General Atomic Div., General Dynamics Corp., San Diego, Calif.
COMPARISON OF BeO VERSUS GRAPHITE AS A MODERATOR FOR MGCR. W. P. Wallace and M. T. Simnad. September 1959. 11p. (Contract AT(04-3)-187)

The comparison is made on the basis of nuclear requirements, properties, cost, and performance under irradiation. Results of published work were reviewed on the effects of irradiation on beryllium oxide and beryllium oxide-uranium dioxide dispersions. A research proposal for a Maritime Gas-cooled Reactor Moderator is included.

GAMD-1207

General Atomic Div., General Dynamics Corp., San Diego, Calif.
PRELIMINARY COMPARISON OF URANIUM AND THORIUM FUELING FOR BeO REACTOR. T. H. Pigford and E. A. Mason. January 1960. 22p. (Contract AT(04-3)-187)

Results are reported of a study made to develop a preliminary

estimate of the relative economics of U^{235}-Th and U^{235}-U^{238} fueling for a BeO-moderated MGCR. The two basic cases used to obtain the nonleakage probabilities were (1) the uranium system, which contains 207.7 kg U^{235} at 5% enrichment and which corresponds to an optimum enrichment and (2) the thorium system, which contains 207.7-kg U^{235} at 93.4% enrichment and 3486-kg of thorium as ThO_2. Effects of a possible reduction in neutron age and a likely increase in gross fission-product cross section are considered. Burn-up calculations and cost estimates were made for the case of no stainless steel in the core, which were used to indicate the economics of possible unclad or ceramic-clad MGCR cores. Tabulated results include the following: reactor-core and fuel-element description, effective thermal cross sections, core composition and relative thermal flux, integral nuclear data for uranium and thorium basic designs, neutron balances for cases 1 and 2, unit cost assumptions, and calculated results. The core life is given as a function of initial fuel enrichment for clad and unclad fuel.

GEMP-6A

General Electric Co. Flight Propulsion Lab. Dept., Cincinnati
HIGH TEMPERATURE MATERIALS PROGRAM. PROGRESS REPORT NO. 6, PT. A, SEPTEMBER 15-NOVEMBER 15, 1961. December 1961. 16p. (Contract AT(40-1)-2847)

Summary of developments in the radiation effects study of a composition series of BeO with and without additions of MgO and ZrO_2.

IDO-28565

Aerojet-General Nucleonics, San Ramon, Calif.
ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. MONTHLY PROGRESS REPORT FOR OCTOBER 1960. November 1960. 94p. (Contract AT(10-1)-880)

Zero power tests were completed on the Gas Cooled Reactor Experiment Core 1B-2L, and work was initiated to repair the gas leak in the lower reactor flange. Fabrication progressed satisfactorily on the ML-1 reactor package. The 1B-2T-1 test in the BRR was terminated after accumulating 1940 hr of irradiation. Data from corrosion tests on Hastelloy X in air and reference gas for 5000 hr at 1750°F are summarized. Irradiation of BeO-UO_2 capsule was continued. A preliminary draft of a feasibility study for a dual-cycle advanced power system was completed.

JPRS-2570

VAPOR PRESSURE OF OXIDES OF LITHIUM: BERYLLIUM, BORON, SILICON AND LEAD. An. N. Nesmeyanov and L. P. Firson. Translated from Izvest. Akad. Nauk S. S. S. R., Otdel. Tekh. Nauk, Metal. i Toplivo, No. 3: 150-1 (1959). 5p.

The vapor pressure of equilibrated heavy oxides of lithium, beryllium, silicon, lead, and fused boron oxide was measured by an integral variant of the effusion method. The vapor pressures of beryllium, silicon, and lead oxides, were measured by vaporization of these substances from an open surface vacuum. The condensation coefficients of these oxides were close to unity.

NAA-SR-3727

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

THE VAPORIZATION OF BERYLLIUM OXIDE. B. D. Pollock, A. M. Saul, and T. A. Milne. March 1960. 18p. (Contract AT (11-1)-GEN-8)

The volatilization of beryllium oxide was studied by use of the Knudsen method and a tungsten cell at 2123 to 2475°K. The degree of interaction of beryllia with tungsten was also determined by observing the amount of tungsten loss associated with the complete volatilization of a known amount of beryllium oxide. Previously published data, obtained by use of a mass spectrometer, were used to estimate the relative importance of various molecular species. Upper limits for the free energies of reaction of tungsten and monatomic oxygen to form WO_2(g) and WO_3(g) at 2242°K are -62.4 and -124 kcal, respectively. The importance of molecular beryllia was assessed by comparison of the measured rates of effusion of beryllium with those calculated for dissociation. The effusion experiment data are in agreement, within experimental errors, with mass spectrometric data taken at 2242°K and show a temperature dependence consistent with the mass spectrometrically determined heats of vaporization of the more important polymers.

NAA-SR-5833

Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.

VACUUM INDUCTION MELTING AND CASTING OF THORIUM AND THORIUM-URANIUM ALLOYS. N. H. Katz, E. G. Kendall and M. H. Binstock. October 1961. 25p. (Contract AT(11-1)-Gen-8)

Evaluation of surface and internal defects, homogeneity of composition and metallurgical properties of Th and alloys of Th-1-13 wt. % U prepared by vacuum induction casting using graphite crucibles coated with oxides of Y, Th, Zr and Be.

NAA-SR-6425

Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.

BERYLLIUM OXIDE SINGLE CRYSTAL GROWTH. PT. 1. ALKALI MOLYBDATA METHOD. S. B. Austerman and A. R. Hopkins. January 1962. 40p. (Contract AT (11-1)-GEN-8)

NAA-SR-Memo-1887

Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.

SURVEY OF MECHANICAL PROPERTIES DATA OF CERAMIC MATERIALS. R. Chang. March 1957. 16p.

Recently published data on the mechanical properties of ceramic materials, especially oxides, were compiled. Values for compressive strengths, relative creep rates, tensile strengths, strengths under shear by torsion, modulus of rigidity, and modulus of elasticity were determined for Al_2O_3, BeO, MgO, ZrO_2, $MgO \cdot Al_2O_3$, and $ZrO_2 \cdot SiO_2$. Values from impact testing of Al_2O_3 was determined. Physical properties of ThO_2 were investigated. The modulus of rupture as a function of temperature was determined for pressure-sintered SiC. The effects of particle size and test temperature on the modulus of rupture of UO_2 specimens were investigated.

NAA-SR-Memo-2055

Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.

SPECTROGRAPHIC MONITORING FOR AIRBORNE BeO. Stanley B. Austerman and Frances Farrah. (195?) 13p.

The equipment and methods used to analyze monitor samples of BeO are described. Analysis of between 0.01 and 20 μg Be can be performed, allowing detection of either very low concentrations of Be or rapid release of large quantities.

NEPA-598

Northrop Aircraft, Inc., Hawthorne, Calif.

STABILITY OF BERYLLIUM OXIDE IN HYDROGEN AT ELEVATED TEMPERATURES IN THE PROGRAM ON THE STABILITY OF REFRACTORY ELEMENTS AND COMPOUNDS IN A HYDROGEN ATMOSPHERE AT ELEVATED TEMPERATURES. L. A. Ohlinger. May 1948. 14p. (NRR-143) (Contract W-33-08-ac-14801(16250))

Samples of BeO were subjected to a series of heat treatments to determine the stability of this material at elevated temperatures in a H_2 atmosphere. Comparable runs were made in a He atmosphere to isolate effects of heat from those of the reducing atmosphere. The results indicate that BeO as a structural refractory should be limited to temperatures below 1600°C. The tests also indicate the danger of utilizing C in contact with BeO when operating in H_2 at elevated temperatures.

NMI-1227

Nuclear Metals, Inc., Concord, Mass.

STRESS-RUPTURE PROPERTIES OF BERYLLIUM CONTAINING CARBIDE AND OXIDE DISPERSIONS. J. Greenspan. March 1960. 23p. (Contract AT(30-1)-1565)

Dispersion-strengthened systems of beryllium containing beryllium oxide or beryllium carbide were formed and the stress-rupture properties determined at 1200, 1350, and 1500°F. Creep deformation of both systems was studied.

NP-8669

Battelle Memorial Inst., Columbus, Ohio

INVESTIGATION OF SINTERABLE POWDERS AND BERYLLIUM OXIDE PROPERTIES. QUARTERLY REPORT NO. 4. J. E. Johnson, C. Hyde, and W. H. Duckworth. April 1960. 17p. (Contract AF 33(616)-6238)

The scatter in modulus-of-rupture data of MgO specimens was reduced by surface grinding. An attempt to characterize sinterable MgO powders by differential thermal analysis was unsuccessful. Experiments are reported in which the relation of calcining conditions with MgO powder sinterability was examined. The most sinterable powder was obtained by calcining $MgCO_3$ at 1500°F. Using this powder, an experiment was also conducted to evaluate the strength of ceramics sintered with various heating rates to 2750°F. The highest density (about 96.8% theoretical) was obtained by heating specimens at 400°F per hour. Specimens heated at 100, 250, or 400°F per hour had essentially the same modulus of rupture. This may indicate that strength is not sensitive to this variable. Data on newly obtained BeO powder are tabulated. It was observed that these powders are not particularly sinterable. Ceramics were produced with densities of 94 to 95% of theoretical when compacted for 2 hours at 40,000 psi and sintered for 2 hours at 2750°F in hydrogen.

NP-9495

Battelle Memorial Inst. , Columbus, Ohio
INVESTIGATION OF SINTERABLE POWDERS AND BERYLLIUM OXIDE PROPERTIES. SIXTH QUARTERLY REPORT. C. Hyde and W. H. Duckworth. November 1960. 15p. (Contract AF 33(616)-6238)

Little or no effect of sintering atmosphere was observed in the densification of compacts of MgO powders at 800 and 1100°F. Moisture in the sintering atmosphere impeded densification. A 1100°F calcine sintered to a density of 97.2 percent theoretical at 2200°F in dried O or N; in normal air a sintering temperature of 2400°F was required to achieve this density. When the basic carbonate was overcalcined at 2400°F, Cl in the atmosphere promoted densification of the MgO powders, as did the use of a vacuum atmosphere at sintering temperatures above 2200°F. Soaking compacts of the 2400°F calcine for 50 hr produced greater densification than did a 1-hr soak, especially at higher sintering temperatures.

NP-9605

Brush Beryllium Co. , Cleveland
INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. PROGRESS REPORT NO. 5 FOR APRIL 16, 1960 TO JULY 15, 1960. TECHNICAL REPORT NO. 183. Jonathan Booker, Robert M. Paine, and A. James Stonehouse. July 1960. 31p. (Contract AF 33(616)-6540)

Progress on the properties of intermetallic beryllides and silicides under investigation is reported. Evaluation of the oxidation resistance of Hf_2Be_{21} and WSi_2 is discussed. Introductory work on the quantitative determination of the rate of oxidation of $ZrBe_{13}$ is reported. The oxidation products of this compound are identified as $ZrBe_{17}$ and BeO and the overall rate of oxidation follows the cubic rate law. Thermal expansion data for WSi_2 and enthalpy data for Ta_2Be_{17} are given. With these data the experimental measurement of thermal expansion and enthalpy are completed for all the compounds under investigation. Additional transverse-rupture data are reported for WSi_2 and Hf_2Be_{17}.

NP-10346

Beryllium Corp. , Reading, Pa.
DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. K. C. Taber and E. E. Weismantel.

ORNL-3183

Oak Ridge National Lab. , Tenn.
THE CALCINATION IN AIR OF BERYLLIUM OXALATE TRIHYDRATE TO BERYLLIUM OXIDE. R. L. Hamner and L. A. Harris. October 1961. 16p. (Contract W-7405-eng-26)

ORNL-3220 (Pt. 1)

Oak Ridge National Lab. , Tenn.
DISSOLUTION OF BeO- AND Al_2O_3-BASE REACTOR FUEL ELEMENTS. PT. 1. K. S. Warren, L. M. Ferris, and A. H. Kibbey. February 1962. 24p. (Contract W-7405-eng-26)

Processing of Hastelloy X clad BeO-base fuels containing 60-70% UO_2 by mechanical stripping or chopping of the cladding followed by leaching of the uranium from the fuel pellets with boiling HNO_3 or by dissolution of the cladding and the UO_2 in a boiling HNO_3-HCl solution.

ORNL-TM-1
Oak Ridge National Lab., Tenn.
QUARTERLY PROGRESS REPORT FOR CHEMICAL DEVELOPMENT SECTION B, APRIL-JUNE 1961. R. E. Blanco. November 1961. 92p. (Contract W-7405-eng-26)

ORNL-TM-94
Oak Ridge National Lab., Tenn.
EXPERIMENTAL ATTEMPTS TO STABILIZE A CUBIC FORM OF BeO. R. E. Thoma, H. A. Friedman, and T. N. McVay. December 1961. 7p. (Contract W-7405-eng-26)

P-1713 (RAND)
RAND Corp., Santa Monica, Calif.
A DISCUSSION OF THE CORRELATION OF CRITICAL CONDITIONS FOR BARE HOMOGENEOUS REACTORS. Benjamin Pinkel and George B. W. Young. June 1959.

Patent - Belgian 569,700
PREPARATION OF SINTERED BERYLLIUM OXIDE. (Commissariat a l'Énergie Atomique) September 6, 1957. (French)

Patent - Belgian 575,534
MANUFACTURING PROCESS FOR NUCLEAR MATERIALS AND FUELS. (Office National de'Etudes et de Recherches Aeronautiques) Priority date, February 14, 1958.

Patent - British 833,667
AN IMPROVEMENT IN A METHOD OF OBTAINING SINTERED BERYLLIUM OXIDE. (to Commissariat a l'Énergie Atomique) April 27, 1960.

A process is presented which produces sintered BeO by calcining $Be(OH)_2$ and sintering at 1700°C and high pressures. A small quantity of acid ions or Be salt of mineral acid is added up to 1%. $BeSO_4$ is recommended. This addition lowers the time, temperature, and pressure of sintering.

Patent - British 878,911
IMPROVEMENTS IN NUCLEAR FUEL. (To General Electric Co.) October 4, 1961.

Patent - French 1,196,192
FUEL ELEMENT. (to Escher Wyss. Soc. Anon.) May 25, 1959.

A fuel element for a gas-cooled reactor is described consisting of two coaxial perforated ceramic tubes (BeO or ZrO_2), between which particulate fissile material is applied. The coolant gas is forced to enter the perforations of the outer tube and to leave the element through the inner tube. The fuel element can be directly introduced into a reactor channel or can be surrounded by a coaxial Al or Zr pressure tube.

Patent - French 1,203,228
FUEL ELEMENT FOR NUCLEAR REACTOR. (to Hawker Siddeley Nuclear Power Co., Ltd.) July 27, 1959.

A canned fuel rod is described which is provided with an axial cavity over its entire length, this cavity being closed at its extremities by the can. The cavity may be filled with a dispersion of a fissile or fertile oxide or carbide in graphite, beryllium, or BeO.

Patent - French 1,206,858
CERAMIC NUCLEAR FUEL ELEMENTS. (to Compagnie des Meules Norton) August 31, 1959.

Methods are given for manufacturing cylindrical, spherical, annular or disk-shaped fuel elements, which consist of an envelope of a refractory metal oxide (Al_2O_3, MgO, ZrO_2, CaO, CeO_2, BeO, ThO_2 or their mixtures) enclosing a core of a fissile and/or fertile metal oxide, to which one or more such oxides may be added. These fuel elements are characterized by a high temperature corrosion and radiation resistance and are highly retentive of fission products.

Patent - French 1,210,254
FUEL ELEMENT FOR HIGH TEMPERATURE NUCLEAR REACTOR. (to Electricité de France) September 28, 1959.

The fuel element consists of a metallic core and a ceramic or refractory can which is permeable to fission gases but impermeable to liquid uranium and has a low neutron absorption. Preferred canning materials are graphite, BeO, MgO, and Al_2O_3. In an embodiment of the invention the can consists of a cylindrical container and a top cover. The cylinder can be provided with lateral centering fins.

Patent - French 1,250,220
ASSEMBLING ELEMENTS, PARTICULARLY NUCLEAR FUEL ELEMENTS. (To Sylvania Corning Nuclear Corp.) November 28, 1960.

Patent - U.S. 2,974,012
PREPARATION OF BERYLLIUM OXIDE OF HIGH PURITY. R. Cooperstein and G. R. Anderson. March 7, 1961.

A process is given for the preparation of beryllium oxide of high purity. A beryllium compound selected from the group consisting of beryllium oxide, beryllium hydroxide, beryllium sulfate, beryllium carbonate, and beryllium nitrate is reacted with molten exalic acid to produce beryllium oxalate from the associated impurities, filtering said leach solution to separate it from unreacted beryllium compound and the more insoluble oxalates, cooling the leach solution to crystallize the beryllium oxalate, recovering the beryllium oxalate by filtration, and subsequently converting the beryllium oxalate to beryllium oxide by pyrolysis.

Patent - U.S. 3,000,734
SOLID STATE FABRICATION OF HARD, HIGH MELTING POINT, HEAT RESISTANT MATERIALS. Nicholas J. Grant and Claus G. Goetzel. September 19, 1961.

Patent - U.S. 3,024,110
PROCESSES FOR PRODUCING DISPERSIONS OF REFRACTORY METAL OXIDE IN MATRIX METALS. P.C. Yates and J.T. Funkhouser. March 6, 1962.

Fusion, quenching, grinding, chemical reduction, sintering and compacting techniques used in producing dispersions of refractory metals in Fe, Co, Ni, Cu, Cd, Tl, Ge, Sn, W, Re, Au and other metal matrices.

TID-7602 (Pt. 1) (38p.)
U.S. Atomic Energy Commission, Washington, D. C.
BERYLLIUM OXIDE MEETING, PROCEEDINGS. December 1-2, 1960.

Paper presented at a meeting held at Oak Ridge National Laboratory, December 1-2, 1960. Topics include fabrication and irradiation testing of $BeO-UO_2$ ceramic fuel pellets. Papers are abstracted separately.

TID-7602 (Pt. 1) (p. 1-11)

U. S. Atomic Energy Commission, Washington, D. C.
FABRICATION DEVELOPMENT OF BERYLLIUM OXIDE-URANIUM DIOXIDE CERAMIC FUEL AT AEROJET-GENERAL NUCLEONICS. Paper from BERYLLIUM OXIDE MEETING, PROCEEDINGS. J. F. Ward and C. W. Funk. December 1-2, 1960.

Pelletizing methods, including blending of powders, mixing with binder and lubricants, granulation, drying pelletizing and sintering used to prepare 70.5% UO_2-29.5% BeO, ceramic fuel pellets for use in an experimental gas cooled reactor.

TID-7602 (Pt. 1) (p. 12-16)

U. S. Atomic Energy Commission, Washington, D. C.
IRRADIATION TESTING OF BERYLLIUM OXIDE-URANIUM DIOXIDE BODIES AT BATTELLE. Paper from BERYLLIUM OXIDE MEETING, PROCEEDINGS. John E. Gates. December 1-2, 1960.

Effects of irradiation at 1450-1725°F and postirradiation heating on the microstructure and dimensions of clad cylindrical specimens prepared by cold pressing and sintering of UO_2 and BeO powders. Use of Hastelloy X and Type 316 stainless steel as cladding.

TID-7602 (Pt. 1) (p. 17-26)

U. S. Atomic Energy Commission, Washington, D. C.
THE IRRADIATION TESTING OF BERYLLIUM OXIDE-URANIUM DIOXIDE FUEL PELLETS BY GENERAL ATOMIC. Paper from BERYLLIUM OXIDE MEETING, PROCEEDINGS. Dale E. Johnson and J. Martin Tobin. December 1-2, 1960.

Effect of irradiation on density, dimensions, grain structure and crushing strength of BeO-UO_2 fuel pellets containing 70-80 vol. % BeO. Basis for the selection of particle size for the fuel dispersions.

TID-7602 (Pt. 1) (p. 27-28)

U. S. Atomic Energy Commission, Washington, D. C.
BERYLLIUM OXIDE WORK AT LOS ALAMOS SCIENTIFIC LABORATORY. Paper from BERYLLIUM OXIDE MEETING, PROCEEDINGS. J. R. Hopkins. December 1-2, 1960.

Use of Be metal housed within a long BeO tube as the collector in a plasma thermocouple reactor.

TID-7602 (Pt. 1) (p. 29-30)

U. S. Atomic Energy Commission, Washington, D. C.
RESEARCH ON BERYLLIUM OXIDE AND FUELED BERYLLIUM OXIDE AT THE OAK RIDGE NATIONAL LABORATORY. Paper from BERYLLIUM OXIDE MEETING, PROCEEDINGS. W. O. Harms. Dec. 1-2, 1960.

Summary of preparation methods and resultant properties, including preparation of high purity BeO by calcination of beryllium oxialite by solvent extraction and by precipitation from fluoride melts; phase relationships in BeO-metal oxide systems; sinterability of BeO powder; effect of irradiation on dimensions and density; coating of UO_2 particles with BeO; and the fabrication of fueled BeO.

TID-11295 (Suppl.)

Division of Reactor Development, AEC
NUCLEAR FUELS AND MATERIALS DEVELOPMENT (SUPPLEMENT). February 1961. 52p.

Fuels. Long thin plates of U-3.8 Mo-0.2 Al were cast. The densities and viscosities of liquid Pu and Pu-Fe eutectic mixture were meas-

ured up to 925°C. Phase equilibrium diagrams of the Pu-Cu and Pu-Ce-Cu systems were determined. Uranium silicide was investigated for use as a high-temperature, long-burnup fuel. Preparation, fabrication, mechanical properties, and compatibility with Nb alloys is discussed for uranium carbide. Properties of PuC and PuC-UC mixtures were studied. Irradiation Testing. Measurable diffusion occurred through the Al_2O_3 coatings of irradiated UO_2 pellets. The irradiation behavior of PuC, UC-20 wt. % PuC, Pu-1 wt. % Al, Th-Pu, U-Pu-Fissium, and Zr-Pu alloys was investigated. Irradiations of U-5 wt. % fissium alloy indicated that the alloy will be able to withstand the desired EBR-II core conditions. Th-U alloys were irradiated to determine their suitability for high-temperature fuel elements. Fabrication. BeO-30% UO_2 dispersions were fabricated by cold pressing and sintering to 95% theoretical density for irradiation tests. Differential thermal analysis and thermogravimetric studies were made of the calcination of $BeC_2O_4 \cdot 3H_2O$. Cladding and Container Materials. Nb was studied for use both as cladding and as a bond and diffusion barrier material between a U alloy fuel and Al cladding for organic cooled reactors. Phase equilibria of the Nb-Zr system were determined. Long-term corrosion tests were performed on a low-Si, Al alloy A288 containing 1 wt. % Ni, 0.5 wt. % Fe, 0.1 wt. %, Ti, and 0.001 wt. % Si max. The development of Zr alloys for cladding and jackets for use in superheated steam continued. The corrosion behavior of Fe in water containing O_2 was investigated. Liquid-Metal Compatibility Studies. Batches of commercial K were purified by hot gettering and subsequent cold trapping to produce a relatively pure material for use in compatibility and heat transfer experiments. Nine refluxing K compatibility tests were conducted to provide screening information regarding the comparative corrosion resistance of Fe, Ni, Co, and Nb alloys. Results of boiling K loop tests are discussed. Nondestructive Testing Development. Studies of ultrasonic behavior in thin sections were directed toward the detection and evaluation of nonbond areas in clad structures. Development of a suitable technique and calibration of gamma spectrometry equipment for U-Al core blanks were essentially completed. The dual-frequency, probe-type eddy current inspection technique was employed in the inspection of Zircaloy-2 tubing. Neutron radiography techniques are discussed.

WADD-TR-60-108
Battelle Memorial Inst., Columbus, Ohio
INVESTIGATION OF SINTERABLE POWDERS AND PROPERTIES OF BERYLLIA CERAMICS. PERIOD COVERED: FEBRUARY 15, 1959 THROUGH DECEMBER 31, 1959. James E. Johnson, A. K. Smalley, and Winston H. Duckworth. March 1960. 23p. (Project No. 7371) (Contract AF 33(616)-6238)

Information was developed on the effects of processing variables and microstructure on the fracture strength of ceramics made from sinterable oxide powders. The characteristic of high strength associated with low porosities and small average crystal sizes was observed in ceramics of both MgO and BeO, but no quantitative correlation was found. Highest strengths were obtained when time and temperature of sintering were sufficient for densification above about 96% theoretical, provided that the sintering time and temperature was insufficient to give crystal sizes larger than the smallest observed, 5 to 6 microns for BeO ceramics and 10 microns for MgO ceramics. In the case of BeO

powder prepared by pyrolysis of high-purity sulfate, calcining to an intermediate temperature (1700 to 1800°F) gave powder that densified most readily when compacted and sintered, but one that did not have the greatest tendency toward crystal growth. The lack of quantitative correlations between bulk density, average crystal size, and strength, indicated that strength was affected by some factor or factors other than these two.

WADD-TR-60-185

Ledoux and Col, Teaneck, N. J.
RESEARCH ON ANALYTICAL METHODS FOR THE DETERMINATION OF OXYGEN IN BERYLLIUM. Silve Kallmann, Fred Collier and Robert Liu. March 1960.

Determination of total oxygen in Be metal by the inert gas fusion method. Study of the differential solubility of Be needed to release the oxygen from refractory BeO.

WADD-TR-60-425

Wright Air Development Div. Materials Central, Wright Patterson AFB, Ohio
MECHANICAL PROPERTIES OF BERYLLIUM. A. E. Riesen and R. T. Ault. September 1960. 35p. (AD-249393)

WAPD-BT-20 (p. 1-22)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh
THE EFFECTS OF IRRADIATION ON $BeO + UO_2$, $ThO_2 + UO_2$, AND $ZrO_2 + CaO + UO_2$. W. Yeniscavich and M. L. Bleiberg.

Three constitutionally different ceramic fuels sealed in Zircaloy-2 were exposed to reactor irradiation in a hot-water loop to burn-ups of about 10^{21} fissions/cc. It was found that dispersion fuels of 28 wt. % UO_2 in a BeO matrix were dimensionally unstable owing to the formation and subsequent agglomeration of large fission-gas bubbles and also because of the destruction of the BeO crystal lattice by fission fragments. Two-phase ceramic fuels consisting of cubic stabilized ZrO_2 and $CaZrO_3$ were only slightly affected by irradiation but exhibited gross dimensional instability when exposed to simultaneous irradiation and corrosion; solid solutions of 14 wt. % UO_2 in ThO_2 were found to be essentially unaffected by the irradiation exposure.

Y-1302

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
A METHOD FOR HOT-PRESSING LARGE DIAMETER BERYLLIUM OXIDE RINGS. L. M. McLaughlin and A. H. Ballard. May 1960. 14p. (Contract W-7405-eng-26)

A method for hot-pressing thin-wall BeO cylinders to high density and close tolerances with lengths to 4.63 in. and diameters to 10.5 in. is presented. The results of several nondestructive tests are given.

Y-1324

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
ANALYTICAL METHODS IN THE BERYLLIUM PROGRAM. J. M. Googin. December 1960. 12p. (Contract W-7405-eng-26)

The dependency of the physical-metallurgical properties of beryllium on the purity of the metal has dictated a rather complete characterization of the metal purity. Direct assay of the beryllium content of the metal can provide only a rough indication of the overall purity due to the limitations of existing methodology. Spectrography of trace impurities

in beryllium or beryllium oxide has extended to account for some 58 elements. Additional analytical methods were developed and/or evaluated for the determination of beryllium oxide, beryllium nitride, beryllium carbide, iron, thorium, and uranium. The status of these methods is discussed along with some experimental methods which show promise. An instantaneous beryllium air monitor and an automatic spectrograph for trace beryllium analysis are discussed in relation to the health hazards associated with beryllium.

Y-1357

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
DETERMINATION OF URANIUM AND YTTRIUM IN BERYLLIUM OXIDE BY X-RAY FLUORESCENCE. G. E. Walden. August 1961.

Application of X-ray spectroscopy to the determination of 1-10% uranium and 1 to 12% yttrium in beryllium oxide using Rb as a common internal standard.

Y-1377

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
A DISSOLUTION STUDY OF HIGH FIRED $BeO-UO_2$ CERAMICS BY FUSION. F. W. Postma, Jr. and R. E. Barringer. December 1961. 12p. (Contract W-7405-eng-26)

SECTION V. BERYLLIUM METALLURGY

PART A. GENERAL METALLURGY

Asundi, M. K.
THE ROLE OF LIGHT METALS IN NUCLEAR ENGINEERING. Paper from "Symposium on Light Metal Industry in India". National Metallurgical Laboratory, Jamshedpur, India, 1961, p. 171-179.
Analysis of creep and corrosion behavior, sintered density, elongation, ductility and other properties essential to the application of Al and Al alloys, Mg and Mg alloys, Be, Magnox alloys and Mg-Zn alloys in nuclear reactors.

Atomic Energy Commission
CIVILIAN POWER REACTOR PROGRAM. PT. 3. STATUS REPORT ON GAS-COOLED REACTORS AS OF 1959. 1960, 83p.
Core materials discussed include graphite as a moderator... Be and graphite for fuel cladding...

Bakish, Robert
THE THIRD ELECTRON BEAM SYMPOSIUM. Journal of Metals, v. 13: 641-644 (September 1961)
Summary of a symposium held at Boston on March 23 and 24. Subjects covered include physics of electron beams; electron beam welding; use as radiation source on electron probe microanalyzers, microminiaturization; and an ion beam system for microcircuitry production.

Bennett, K. W.
ELECTRIC MACHINING BUILDERS SIGHT MARKET BREAKTHROUGH. Iron Age, v. 188: 72-73 (September 1961)

Coffinberry, A. S.
LATER PLUTONIUM METALLURGICAL RESEARCH AT LOS ALAMOS. Chapter 5 from "The Metal Plutonium". The University of Chicago Press, Chicago, Illinois, 1961, p. 36-62.
Review of physical metallurgy studies for developing nuclear reactor fuels, particularly in alloying Pu with Al, Mg, Ti, V, Ni, Zr, Mn, Fe, Co, Mo and Ce. Studies include crystal structure changes during phase transformations, development of low melting point binary and ternary eutectics for liquid fuel reactors and study of health hazards in handling Pu.

Dayton, R. W., E. M. Simons, and R. W. Endebrock (Battelle Memorial Inst., Columbus, Ohio)
REACTOR CORE MATERIALS. Technical Progress Review, v. 4, No. 2: (May 1961)
Developments in uranium, alpha, gamma and epsilon uranium alloys, Pu and its alloys, Th, refractory fuel and fertile materials, dispersion fuels, mechanisms of corrosion of fuel alloys and basic studies of radiation effects in fuel materials, graphite, Be metal and alloys, Be compounds and solid hydrides. Mechanical properties and metallurgical aspects of cladding and structural materials, melting, casting, cladding, welding and brazing.

Dennis, W. H.
METALLURGY IN THE SERVICE OF MAN. Pitman Publishing Corp., London, 1961, 372p.
Basic metallurgy text covering the concentrating, smelting and refining of the ore as well as the casting, shaping, heat treating and testing of metals and alloys with emphasis on light weight, minor, precious and rare earth metals and the nuclear application of uranium.

Dieter, G. E., Jr.
MECHANICAL METALLURGY. McGraw-Hill Book Co., New York, 1961, 615p.
Mechanical deformation methods and resultant behavior of materials. Topics include elasticity, plasticity and advanced strength of materials, crystal deformation and dislocation theory. Testing methods examine fatigue, creep, brittle fracture and stress rupture properties. Plastic forming of metals including forging, rolling, extrusion and drawing. Emphasis on the influence of metallurgical structure on mechanical properties.

Eyre, P. B. (United Kingdom Atomic Energy Authority, Risley, Warrington, England
FACILITIES FOR THE FABRICATION OF BERYLLIUM. p. 403-17 of "Fuel Element Fabrication with Special Emphasis on Cladding Materials. Volume 1". London and New York Academic Press, 1961.
Investigation of the handling, storage, fabrication and prevention of contamination of Be.

Fabian, Robert J.
AEROSPACE MATERIALS: WHERE WE STAND TODAY. Materials in Design Engineering, v. 54: 94-97 (December 1961)
Summary of symposium papers on the following topics: ceramic and intermetallic materials; magnetic core materials as affected by neutron radiation and high temperature; coatings for insulation of space vehicles; tungsten alloys; refractory metals; ablative materials and expandable structures suitable for space applications.

Finniston, H. M.
BERYLLIUM: A PROBLEM METAL. Research Applied in Industry, v. 15: 109-118 (March 1962)
Review of ductility and preferred orientation, characteristics, alloying behavior, corrosion resistance and nuclear reactor applications of Be at 0-1000°C. Comparative creep data are given for Be, wrought carbon steel, 18/18/Cb stainless steel and Nimonic 80A. Survey of extraction and fabrication processes.

Finniston, H. M. and J. P. Howe, Eds.
PROGRESS IN NUCLEAR ENERGY. Series 5. METALLURGY AND FUELS. Vol. 3. Pergamon Press, Inc., New York, 1961, 476p.
Review of reactor material studies including preparation of fuel elements, high temperature testing of potential fuel materials and investigation of solid state physics irradiation effects.

Gage, Paul E.
WHAT BERYLLIUM CAN DO FOR YOU. Product Engineering, v. 32: 82-85 (February 1961)
Mechanical and physical properties of Be are compared to light, heavy, reactive and refractory metals, stainless steels and superalloys.

Applications in environments requiring high thermal stability and good strength to weight ratio.

Gatos, H. C., J. W. Faust, Jr., and W. J. LaFleur, Eds.
SURFACE CHEMISTRY OF METALS AND SEMICONDUCTORS. John Wiley & Sons, Inc., New York, 1960, 526p.

Gilman, John J.
ULTRAHIGH STRENGTH MATERIALS OF THE FUTURE. Mechanical Engineering, v. 83: 55-59 (September 1961)
Strength evaluation for monocrystals composed of interstitial compounds of the transition metals or of covalent compounds of the light metals. Chemical and mechanical properties are evaluated for carbides, borides and nitrides of transitional metals.

Gore, James K. and James J. Glass
THE PRACTICAL APPLICATION OF STATISTICS TO THE QUALITY CONTROL OF ELECTROPLATED PRODUCTS. Paper from "48th Annual Technical Proceedings". American Electroplaters' Society, Inc., Newark, 1961, p. 115-119.
Uses of variables criteria in acceptance sampling of plated parts. Normal distribution curve of plating thicknesses and effects of high standard deviation and low lot averages. Calculations involved and results obtained using statistical quality control plan in the inspection of Au and Ag plated parts.

Green, Leon
REACTOR-COOLANT PROPERTIES. Nucleonics, v. 19: 140-144 (November 1961)
Physical, thermal and nuclear properties given for liquid metals, gases and aqueous and organic liquids include, for example, melting point, boiling point, heat transfer coefficient, thermal stability, radiation stability, radioactivity, moderating power, etc.

Hardy, C. J. and D. Scargill
THE DISSOLUTION OF BERYLLIUM IN AQUEOUS SOLUTIONS OF MINERAL ACIDS AND AMMONIUM FLUORIDE. Chemical Society Journal: 2658-2663 (July 1961)
The rate of dissolution in aqueous solutions of nitric, sulphuric, hydrochloric and hydrofluoric acid and of ammonium fluoride, varies with the source and method of fabrication of the metal, acid concentration, temperature, surface properties of the metal and the presence of hydrofluoric acid.

Hessler, B. H.
FABRICATION OF BERYLLIUM SHEET. Light Metal Age, v. 19: 10-12 (February 1961)
Production of Be sheet from a hot pressed Be slab. Cladding, rolling equipment, rolling temperatures, cladding removal, flattening of sheet, reduction ratios, sheet width, joining and research.

Hessinger, Philip S.
BERYLLIA-ENGINEERED SPACE AGE MATERIAL. I&EC (Industrial and Engineering Chemistry) v. 54: 16-21 (March 1962)
Comparison of thermal, electronic and nuclear properties of beryllia, alumina and thoria. Review of fabrication processes including dry and ram pressing, sintering, extrusion, slip casting and machining. Raw material preparation, safety considerations, applications and future trends.

Hodge, Webster
BERYLLIUM. Review of Recent Developments. Defense Metals Information Center, February, 1962, 2p.
Brief summaries of papers presented at a three day Institute of Metals Conference on the metallurgy of Be held in London, October 16-18, 1961. Topics reported include: a precipitation reaction in commercially pure Be, impurity effects in commercially pure Be, the effect of purity and orientation on the deformation of Be single crystals; behavior of dislocations in Be.

Hodge, Webster
BERYLLIUM. Review of Recent Developments. Defense Metals Information Center, August, 1962, 4p.
Review of literature pertaining to the annealing, extrusion, fabrication, and strength and chemical property determinations of Be, Be sheet and Be foil. Included is a report on the toxicity of Be and on the application of Be as a diffusion-bonding agent for joining iron, nickel and cobalt-base alloys.

Hughel, Thomas J.
BERYLLIUM — A SPACE-AGE METAL. Metals Engineering Quarterly, v. 2, No. 2: 42-51 (May 1962)
Availability and price trends of Be and the special properties which make it useful in rockets and space vehicles. Present technical impediments to the use of Be are reviewed, together with steps being taken to overcome them, as in the application to inertial guidance devices.

Inglis, N. P.
FABRICATION AND PROPERTIES OF SOME OF THE NEWER CONSTRUCTIONAL METALS. Institute of Chemical Engineers, Transactions, v. 40: A53-A73 (February 1962)
Review of extraction, melting, forming and welding of Ti, Zr, Be, Cb, Hf, Ta and their alloys. Mechanical properties, alloying ability, application and uses of these metals and alloys.

Jaffe, R. I. , D. J. Maykuth, and R. W. Douglass
RHENIUM AND THE REFRACTORY PLATINUM-GROUP METALS. Paper from REFRACTORY METALS AND ALLOYS. Vol. 11. METALLURGICAL SOCIETY OF AIME. Interscience Publishers, Inc. , New York, 1961, p. 383-463.
Metallurgy of Re, Os, Ir, Ru and Rh is related to processes for other refractory metals. Potential availability, extraction, compaction and fabrication. Special attention given to mechanical properties and deformation characteristics at low and high temperatures. Oxidation and alloy constitution. Effects of additions of Re and Pt group metals on the properties of Mo and W.

Johnstone, Sydney J. and Margery G. Johnstone
MINERALS FOR THE CHEMICAL AND ALLIED INDUSTRIES. 2nd Ed. John Wiley & Sons, Inc. , New York, 1961, 788p.
Sources, nature, modes of occurrence, methods of treatment and products derived from all industrial minerals with particular emphasis on metals intended for use in nuclear fission plants.

Kennedy, A. J.
NEW HORIZONS FOR MATERIALS. Discovery, v. 23: 14-21 (February 1962)
Metallurgical properties such as high temperature deformation, ductility, surface reactivity, melting point, structure, dislocation motion and thermal stability are reviewed for materials including W, Cb, Re, Be, Fe, Ni, Co, Mo, Cr, V, Pt, TaC, HfC, oxides and plastics.

Kjellgren, Bengt R. F.
BERYLLIUM. Chapter 3 from "Rare Metals Handbook". Reinhold Publishing Co., New York, 1961, p. 32-57.
Beryllium oxides and alloys discussed. Occurrence, consumption, derivation, production, extrusion, fabrication and applications. Physical, mechanical, chemical, thermodynamic and toxic properties given.

Kjellgren, Bengt R. F. (National Metallurgical Laboratory)
STATUS OF THE BERYLLIUM INDUSTRY IN THE UNITED STATES OF AMERICA. Technical Journal, v. 3: 37-45 (February 1961)
Detection of beryl source with scintillation counter and Sb gamma-ray source. Mining, crushing, separation and reduction of beryl followed by vacuum casting to produce Be billets. Mechanical and physical properties of Be given.

Kjellgren, Bengt R. F.
STATUS OF THE BERYLLIUM INDUSTRY IN THE UNITED STATES OF AMERICA. Paper from SYMPOSIUM ON LIGHT METAL INDUSTRY IN INDIA. National Metallurgical Laboratory, Jamshedpur, India, 1961, p. 57-67.
Occurrence, production and consumption of beryl ore. Methods for the production of Be metal and BeO, based on the Copeaux-Kawecki and the Sawyer-Kjellgren processes. Examination of the powder-metallurgy process for the production of vacuum pressed Be billets from vacuum cast Be ingots. Physical, chemical and mechanical properties of Be metal. Brief account of the production and applications of Be-Cu; Be-Ni, Be-Al and BeO.

Klopp, W. D.
OXIDATION-RESISTANT COATINGS FOR REFRACTORY METALS. Review of Recent Developments. Defense Metals Information Center, February 1962, 4p.
Comparative evaluation of aluminide, silicade and beryllide coatings on Cb, Ta, Mo and W alloys.

Knoerr, Al and Mike Eigo
BERYLLIUM UPDATE — 1961. Engineering and Mining Journal, v. 162: 87-97 (September 1961)
Survey of Be industry including geology and statistics of ore development; recovery by Van Dornick flotation procedure; physical and mechanical properties of oxides; and applications including preparation of solid fuel rocket propellants.

Krachmal, J. J.
A REVIEW OF SOME USAF REFRACTORY MATERIALS AND THEIR APPLICATIONS. Paper from SEVENTH INTERNATIONAL CERAMIC CONGRESS, TRANSACTIONS. British Ceramic Society, London, 1960, p. 239-245.
High temperature capabilities and service requirements are reviewed for refractory materials including ceramics, graphite, refractory metals, cermets, intermetallic coumpounds, ablative plastics and ceramics coatings. Applications in solid fuel rocket nozzles and as hypersonic leading edges in space craft are evaluated with summary of research on oxidation and thermal resistance, structures and physical and mechanical properties.

Krishnan, R. M., Ed.
SYMPOSIUM ON LIGHT METAL INDUSTRY IN INDIA. National Metallurgical Laboratory, Jamshedpur, India, 1961, 272p.
Compilation of papers presented at the symposium held at Jamshedpur, India on Feb. 14-17, 1961 covering research, production and fabrication techniques, metallography and applications of various light metals including Ti, Be, Mg and Al and its alloys. Review of design and operating characteristics of various types of melting and holding furnaces used in the light metals industry.

Lash, L. D.
RARE EARTH HORIZONS. Journal of Metals, v. 13: 506-507 (July 1961)
Survey of rare earth metals including Sc, Y, La, Ce, Sm, Eu, Pr, Nd, Dy and Gd and their properties, preparation, industrial applications and effects on other elements.

Lee, R. E., Jr.
BEARING MATERIALS AND LUBRICANTS FOR HIGH TEMPERATURES. Engineers' Digest, v. 23: 83-84 (May 1962)
Hardening of gas, sleeve and thrust bearings by heat treating, nitriding, hard Cr plating and flame and plasma-arc spraying to improve strength, dimensional stability, differential thermal expansion, corrosion and oxidation resistance, metal solubility and coefficient of friction. Consideration of oils, platings, oxides and liquid metals as lubricants for the bearings at operating temperatures of about 1800°F.

Letort, Yves
PROGRESS – NEW TRENDS AND THE FUTURE OF REFRACTORIES. British Ceramic Society, Transactions, v. 60: 363-380 (June 1961)
Development of the refractories industry including methods of and instruments for research, properties of refractories and manufacturing processes. Future trends, applications and economic considerations.

Lewis, J. R.
EVALUATION OF BERYLLIDES. Journal of Metals, v. 13: 357-362 (May 1961)
Evaluation of properties, fabrication and nuclear applications of Be and its alloys in terms of density, elastic modulus, melting point, oxidation and impact resistance, hardness and thermal characteristics.

Lewis, J. R.
FURTHER EVALUATION OF BERYLLIDES. Journal of Metals, v. 13: 829-832 (November 1961)
Behavior of $CbBe_{12}$ and $ZrBe_{13}$ at temperatures below 1000°C. Brittle behavior of MBe_{12} and MBe_{13} is to be expected in view of their limited mechanism for plastic slip. A reduction in impurity level could reduce, but probably never eliminate, the low ductility of beryllides. There is evidence for an abrupt change in elastic modulus for $ZrBe_{13}$ and $CbBe_{12}$ at or around 600°C.

Loewenstein, P.
THE STATUS OF BERYLLIUMMETAL IN NUCLEAR REACTORS. PT. I. Atompraxis, v. 8: 122-128 (April 1962) (English)

Long, R. A.
DEVELOPMENT OF NEW NICKEL-BASE BRAZING ALLOYS HAVING DUCTILITY. Welding Journal, v. 40: 259s-264s (June 1961)
Requirements of brazing filler metals. Development of a new brazing alloy based on the ternary system Ni-Mo-Si. Effects of addition of Mn, Cr, Sn, Li, Be, Co and Fe on liquidus and solidus temperatures. Data are given for oxidation resistance, hardness, flow and wetting characteristics and ductility.

McIntosh, A. B. and T. J. Heal, Eds.
MATERIALS FOR NUCLEAR ENGINEERS. Interscience Publishers, Inc., New York, 1960, 373p.
Preparation, fabrication, physical and nuclear properties, mechanical properties, effects of reactor conditions and compatibility of U, Pu, Th, ceramic fuels, graphite, Mg, Be and Zr. Applications in nuclear reactors.

McKeon, E. V.
HOW TO HANDLE BERYLLIUM SAFELY. Iron Age, v. 189: 149-151 (April 1962)
Be is canned, compressed into shapes, forged and machined under special safety conditions which include air-sampling, exhaust systems, vacuuming, cleaning and safety equipment.

Meerson, G. A., D. D. Sokolov, N. F. Mironov, N. M. Bogorad, J. D. Pachomov, D. S. Lovovskij, E. S. Ivanow, and V. M. Smelev
BERYLLIUM. Kernenergie, v. 2: 939-945 (October-November 1960) (German)
Review of Be technology including production by melting $Be_3Al_2Si_6O_{18}$, subsequent leaching and electrolysis or reduction by metallic Mg and processing by hot pressing and extruding at 1120-1150°C under vacuum, pressing and sintering (1180-1200°C) Be powder, vacuum casting and machining. Data for microstructure, mechanical properties and ductility.

Miller, Bernard S.
"EXOTICS" MOVE AHEAD. Metalworking, v. 17: 11-13, 28-29 (October 1961)
Review of fabrication techniques, heat treatment and resultant physical and mechanical properties of refractory and heat resistant metals and alloys with particular reference to Cb, W, Mo, Ta and Be and their alloys with Al, Ti, V, Hf, Zr and Re. Topics include arc and electron beam welding, hot rolling, compaction and sintering, forging

and spinning processes; and high temperature strength, oxidation, ductile-brittle transition, weldability and formability. Survey of applications of sheet and structural shapes including aircraft, rocket and reactor components.

Murray, P. and J. Williams
CERAMIC AND CERMET FUELS. Paper from PROGRESS IN NUCLEAR ENERGY. Series 5. METALLURGY AND FUELS. Vol. 4. METALLURGY OF NUCLEAR REACTOR COMPONENTS. Pergamon Press, Inc., New York, 1961, p. 520-542.

Fabrication methods, high temperature, thermal and mechanical properties and irradiation behavior of fuel dispersions of Pu or U carbide or dioxides alone or in a matrix of Fe, Al, Be, Th, Zr, graphite, alumina, magnesia zirconia, beryllia or silicon carbide.

Newkirk, Arthur E.
PREPARATION AND CHEMISTRY OF ELEMENTARY BORON. Paper from BOROX TO BORANES. Advances in Chemistry Series, ACS, no. 32: 27-41 (1961)

Survey of research on the structure, powder diffraction patterns and preparation including reduction by metals (i. e., with Mg in a vacuum at 1400-1800°C), by electrolysis, by hydrogen from 600-2000°C and by thermal decomposition from 300-1500°C. Purification by chlorination and vacuum fusion from 300-1800°C. Chemical reactions with H, O, N, metals, halogens, water, acids and bases and correlation of preparation conditions with crystal structure.

Paris, Rene
NEW METALS. Chimia, v. 15: 443-449 (September 1961) (French)

Preparation of Be, Ti, Zr, Ta and Cb from their ores. Densities, melting points and boiling points. Tensile strength and heat resistance of Ti alloys containing Al, Cr, Fe, Mn, Sn or V. Transformations in Ti. Ductility of Be as a function of temperature between 20-1000°C.

Petersen, Alfred H.
THE RESPONSIBILITIES OF MATERIALS ENGINEERING. Metal Progress, v. 81: 65-66 (May 1962)

Relationship of the materials engineer to value engineering and cost reduction techniques. The use of advanced materials concepts is illustrated by reference to the Polaris missile project.

Riley, Malcolm W.
THE FUTURE FOR CERAMICS. Materials in Design Engineering, v. 54: 133-140 (September 1961)

Classification of ceramic materials; basic theory of brittleness and ductility; the interdisciplinary approach; progress in cermets, mosaic ceramics and fiber-reinforced ceramics.

Runnalls, O. J. C.
STUDIES ON PLUTONIUM AT CHALK RIVER. Chapter 7 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Illinois, 1961, p. 70-78.

Review of extractive and physical metallurgy research for developing Pu alloys for nuclear reactor fuels. Studies include alloy composition, fabrication and irradiation behavior of Pu-Al alloys; alloying-reduction of PuF_3 with Be, Si, Ga, In, Tl, Mg, Th and U; and phase composition of Pu-transition metal and Pu-Ag alloys.

Ryshkewitch, Eugene
OXIDE CERAMICS – PHYSICAL CHEMISTRY AND TECHNOLOGY. Academic Press Inc., New York, 1960, 472p.
Occurrence, thermal and chemical characteristics, microstructure and phase relationships for alumina, spinel, magnesia, beryllia, zirconia, zirconium silicate, thoria and ceria.

Saarivirta, Matti J.
DEVELOPMENT OF COPPER BASE HIGH STRENGTH-MEDIUM CONDUCTIVITY ALLOYS – Cu-Ti-Ti-Sn AND Cu-Ti-Sn-Cr. Metallurgical Society of AIME, Transactions, v. 221: 596-606 (June 1961)
...conductivity of these alloys are compared favorably above Cu-Be-Co alloys.

Schofield, M.
NOTES ON BERYLLIUM. Mining Magazine, v. 104: 77-79 (February 1961)
Review of refining and fabricating techniques. Physical and mechanical properties. Applications in nuclear reactor components.

Schubert, Jack
BERYLLIUM. McGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY. McGraw-Hill Book Co., Inc., New York, 1960, p. 170-5.

Schweisheimer, W.
SEARCH FOR NEW BERYLLIUM SOURCES. Metall., v. 15: 726-7 (July 1961) (German)
Utilization of neutron emission in exploration for Be. Data given on various applications of the metal.

Sherwood, E. M.
LESS COMMON METALS. I/EC (Industrial and Engineering Chemistry), v. 53: 922-924 (November 1961)
Literature review from June 1960 to May 1961 on electrolytic machining, electrospark discharge machining, electron beam machining and welding, explosive forming, radiofrequency welding, plasma arc cutting, vapor deposition, plasma arc spraying, zone refining, brazing and forming of Be, Cr, Hf, Mo, Cb, Re, Ta, W and Zr.

Smith, A. I.
MECHANICAL PROPERTIES OF MATERIALS AT HIGH TEMPERATURE. Chartered Mechanical Engineer, v. 8: 278-285 (May 1961)
Literature review of recent research in the U. S. and Britain on equipment and procedures for testing materials of such as W, Mo, Ta, Cb, Ti, Be and their alloys. Emphasis on material strengths at high temperatures for use in nuclear reactors, rockets and turbines.

Stetson, A. R. and C. A. Hauck
PLASMA SPRAYING TECHNIQUES FOR TOXIC AND OXIDIZABLE MATERIALS. Journal of Metals, v. 13: 479-482 (July 1961)
Review of equipment and procedure for beryllium-containing and carbide and nitride materials with reference to reduction of toxicity.

Townhill, A.
BERYLLIUM DESCRIBED AS TRUE SPACE AGE METAL. Metals Review, v. 34: 22-23 (January 1961)
Processing of Be from BeO by thermal reduction of BeF_2 or electrolysis of fused salts. Mechanical and chemical properties, applications in space vehicles and nuclear reactors. Powder metallurgy techniques for production of Be forms.

Williams, A. Wyn
MODERN CERAMICS AND CERMETS – STONE AGE MATERIALS MEET NUCLEAR AGE DEMANDS. Chicago Purchasor, v. 39: 20-25 (August 1961)
History and development of ceramics. Physical and chemical properties in comparison with tungsten. Metallurgical applications and use in cutting tools.

Williams, L. R. and P. B. Eyre
BERYLLIUM. Paper from MATERIALS FOR NUCLEAR ENGINEERS. Interscience Publishers, Inc., New York, 1960, p. 269-318.
Review of Be metallurgy including production by metallic reduction or electrolysis; melting, casting and purification; powder production and consolidation; mechanical working, joining and machining; behavior of single crystals; effects of strain rate, grain size and elevated temperatures on tensile, stress rupture and creep properties; neutron cross section, crystal structure, electrical, thermodynamic, thermal, and elastic properties; compatibility with air, hydrogen, carbon dioxide, water, liquid metals and uranium; canning techniques, toxicity and safety precautions in handling.

Yamada, Masami and Zyunitiro Matumoto
NUCLEAR GROUND-STATE ENERGIES. Physical Society of Japan Journal, v. 16: 1497-1529 (August 1961)
Estimates are given of proton and neutron separation energies and beta-decay energies for most of the nuclei that have been discovered or will be discovered in the near future.

Canadian Chemical Processing, v. 45: October 1961, p. 78-80.
MINING AND METALLURGY AT LAKE BERNIC-CHEMALLOY MINES THEM MEDIUM RARE.
Analysis of Canadian pegmatite ores indicate 20% Cs, 2% lithium oxide, 0.2% beryllium oxide, 0.32% tantalite and 0.05% Ga. Chemical and physical properties of Cs, Li and Be are given which permit applications in the electronic, thermoelectric, nuclear, missile and rocket fields.

Chemical and Engineering News, v. 38: November 1960, p. 26-28.
METALS INDUSTRY BOLSTERS CHEMICAL GROWTH.
Production requirements of steel, Al, Mg, Ti, Be, Zr and their products. Use of chemicals in alloying, refining, purification, reduction, separation, coating, heat treating, scarfing, welding, lubrication and other processes.

Chem & Process Eng. 41: January 1960, p. 32-3.
METALS FOR THE NEW AGE. I. C. I. ADDS WROUGHT BERYLLIUM TO ITS PRODUCTION OF 'NEW' METALS.
Production methods and safety hazards in the production of beryllium, titanium, and zirconium are discussed. Applications of the metals are given.

Engineer, v. 212: December 1961, p. 1102-1104.
NATIONAL METAL CONGRESS AND EXPOSITION.
Survey of metallurgical products, processes and equipment introduced at the show including a 25% Ni maraging high-strength steel, pure Co coiled strip with improved ductility and workability, a Ni-Cr resistance alloy heating element; plasma arc surfacing with fully-fused overlays of wear and corrosion-resistant alloys using constricted plasma arc torches and an automatic friction welding machine.

I&EC (Industrial and Engineering Chemistry), v. 54, no. 9: September 1962, p. 57-60.
LESS COMMON METALS AND MODERN CHEMICAL PROCESSING.
Bibliographic survey of high and low temperature mechanical tests and of shaping, joining and coating technique studies for Be, Cr, Hf, Mo, Nb, Re, Ta, W and Zr.

Iron Age, v. 188: October 1961, p. 107
ACTION IN BERYLLIUM.
The capacity and operations of a Be fabrication plant which includes a precision machine shop and an inspection setup including X-ray. Review of the government stockpiling program and of foreign and domestic sources of Be ore.

Iron and Steel Institute, 4 Grosvenor Gardens, London S. W. I., England, 1960, 308p.
THE DETERMINATION OF GASES IN METALS.
Report of a symposium organized by the Society for Analytical Chemistry, in conjunction with the Iron and Steel Institute and the Institute of Metals. Sampling of liquid metals. Determination of gases by micro vacuum fusion techniques, an isotope dilution method and activation analysis. Techniques for analysis of Fe, steel, cast iron, Be and other metals. Papers abstracted separately.

Light Metals, v. 24: October 1961, p. 264-265.
BERYLLIUM AND ITS USES IN OTHER LIGHT METALS.
Effects of Be additions on oxidation rate, workability, gas porosity, thermal stability, dross formation and activity of Mg-Al alloys.

Metal Industry, v. 99: December 1961, p. 437-439.
METALLURGY OF BERYLLIUM.
Review of papers presented at the First International Conference on Beryllium organized by the Institute of Metals. Topics include mechanical and physical properties, corrosion resistance, preparation and fabrication techniques, diagnostic techniques, applications in reactors and aircraft and future trends.

Metal Progress, v. 81: April 1962, p. 161-165.
GLASSES AND CERAMICS FOR THE ENGINEER.
Use of high alumina ceramics, steatites, borosilicate glass and fused quartz for many types of parts. These offer good mechanical strength and resistance to high temperatures.

Metals, v. 37: September 1961, p. 28.
DEVELOPMENT OF JAPANESE TECHNIQUE. (Japanese)
Relationships between the degree of precipitation hardness and mechanical and physical properties of Be-Cu alloys are investigated. A lattice-defect theory is developed and creep corrosion and material failure are studied.

Mining Engineering, v. 14: February 1962, p. 47-51.

METALLIC AND NON-METALLIC MINERAL DEVELOPMENTS OF 1961.

Production and consumption of domestic and imported Al, Sb, Be, Co, Cu, Au, Ag, Pb, Zn, Hg, Ni, Th, W, U, Va, Fe, garnet, asbestos, bauxite, B, portland cement, $FeO \cdot Cr_2O_3$, clay, diatomite, perlite, felspar, CaF_2, $CaSO_4 \cdot 2H_2O$, lime, Li, Mg, Mn, phosphate, K_2CO_3, pumice, slag, slate, S, talc, Ti, $CaSiO_3$ and Zr in 1961.

Missiles and Rockets, v. 10: March 1962, p. 68-70, 138.

AIR FORCE LEADS DRIVE FOR MATERIALS PAYOFFS.

Review of research into high-temperature properties of materials including 1200°F oxidation resistance of coatings for refractory metals, precipitation and dispersion hardening phonomena, magnetic-field effects on heat treatment, melting points of ceramic and intermetallic compounds and temperature limits for polymers.

National Metallurgical Laboratory, Council of Scientific and Industrial Research, Jamshedpur, India. 23p.

SYMPOSIUM ON LIGHT METAL INDUSTRY IN INDIA, PROCEEDINGS (FEBRUARY 14-17, 1961).

Abstracts of papers presented on reduction and refining, fabrication, microstructure and transformations, analysis techniques and industrial application of Be, Ti, Al, Mg, Zn, Cu and their alloys, alumina, Soderberg Paste and other light materials.

National Metallurgical Laboratory, Proceedings, Council of Scientific and Industrial Research, Jamshedpur, India. 12p.

SYMPOSIUM ON PILOT PLANTS IN METALLURGICAL RESEARCH AND DEVELOPMENTS (FEBRUARY 15-18, 1960).

Abstracts of papers presented on pilot plant development, research, uses and limitations and application to pyrometallurgy, Fe ore sintering; beryllium oxide, Mn and MnO_2 and coke production; coal washing, gasification process, steel wire aluminizing and vanadium pentoxide recovery.

Power Reactor Technology, v. 5: March 1962, p. 48-50.

BERYLLIUM.

Review of studies on mechanical and physical properties of and fabrication methods for Be including corrosion behavior in CO_2 at 600°C and above and in He containing 100 ppm H_2O at 700°C, the effect of extrusion technique on texture, techniques for extrusion of finned tubing and rod; mechanical properties of the extruded product and the effect of temperature on neutron irradiation damage.

Reactor Core Materials, v. 3: November 1960, p. 30-47.

CLADDING AND STRUCTURAL MATERIALS.

Data given for corrosion resistance, metal-water reactions, radiation effects, mechanical properties and metallurgical aspects of Al and Ag alloys, Nb, Zr, Yt, Be, Inconel X, Hastelloy X, Hastelloy R-235, stainless and low carbon steels, tungsten oxides, and carboloy.

Reactor Core Materials, v. 4: November 1961, p. 21-30.

MODERATOR MATERIALS.

Space/Aeronautics R&D Technical Handbook, v. 4: 1961-1962, p. I3-I9.
PRODUCTION ENGINEERING – STATE OF THE ART.
A survey of materials and methods employed in maching, conventional forming, high energy rate forming, joining and advanced processes such as plasma spraying, filament winding, diffusion bonding and electroforming.

Steel, v. 149: October 1961, p. 115-116.
1961 METAL SELECTOR.
Composition, physical and mechanical properties and applications are tabulated for refractory, high temperature, cast high, spring, Cu, Be, Al, Ti, Mg, Zn and Zr alloys, stainless, heat resistant, H, alloy, high strength and superstrength steels and ferrous castings.

Steel, v. 149: December 1961, p. 50-54.
NEW MATERIALS, TECHNIQUES INCREASE VERSATILITY OF CERAMICS.
Slip casting, isostatic molding, pressing and extrusion of fine grained Al_2O_3 and oxides of Be, Zr, Ti, porcelain, magnesia, steatite, forsterite, cordierite, pyroceram and lithium-alumino-silicate; into intricate shapes for use at 1830-3090°F. Effect of temperature on stability, hardness, thermal expansion, temperature resistance, porosity, tensile and compressive strength, thermal and electrical conductivity.

AD-209135
Beryllium Corp., Reading, Pa.
BERYLLIUM CASTING. PHASE I: (SEPTEMBER 19, 1958-NOVEMBER 19, 1958). Paul M. Cohen.
Bibliography of literature pertaining to the casting and melting of Be.

AD-237348
Lockheed Aircraft Corp., Sunnyvale, Calif.
BERYLLIUM. A SEARCH OF THE LITERATURE 1957-1959. Kenneth D. Carroll, comp. January 1960, 113p. (LMSD-288190)
The broad field of beryllium metallurgy, crystallography, fabrication methods, and the application of Be to the aircraft and missile fields has been reviewed. References to the use of Be in nuclear reactors, nuclear fuels, and the effects of radiation have been omitted. There are references included as to the toxicology of Be, its hazard limits, and means of detection; however, this phase was of tangental interest and the references are not exhaustive. References to Cu-Be alloys have been omitted, but abstracts are included covering other Be alloys. The majority of the items cited have been abstracted; however, various annual reviews and progress reports were not. In the majority of cases where no abstract accompanies the reference, the title is self-explanatory, there are numerous but somewhat generalized topics discussed, or the item was of peripheral interest to those who had originally requested the compilation of the bibliography.

AD-237593
Lockheed Aircraft Corp., Sunnyvale, Calif.
BERYLLIUM. SURVEY OF THE LITERATURE. K. D. Carroll, comp. April 1960, 1v. 135 refs. (Suppl. no. 1 to Rept. no. LMSD-288190, AD-237348).

AD-244263

Lockheed Aircraft Corp., Sunnyvale, Calif.
BERYLLIUM. SURVEY OF THE LITERATURE. K. D. Carroll, comp. August 1960, 82p. (Suppl. no. 2 to Rept. no. LMSD-288190, AD-237348 and AD-237593).

AD-248985

Materials Advisory Board, National Research Council, Washington, D. C.
STATE-OF-THE-ART REPORT BY THE PANEL ON FORGING AND EXTRUSION OF THE COMMITTEE ON THE DEVELOPMENT OF MANUFACTURING PROCESSES FOR AIRCRAFT MATERIALS. (AMC). October 1960, lv. (Rept. no. MAB-139-M(F3)) (Contract DA 36-039-sc-76436).

AD-253352

Autonetics Div., North American Aviation, Inc., Downey, Calif.
A SELECTED GUIDE TO BERYLLIUM LITERATURE. Marnelle Kinney. March 1961.

Topics include electroplating, fabrication and powder metallurgy techniques for Be-Cu alloys.

AD-258355

Mellon Institute, Pittsburgh, Pa.
THE EVOLUTION OF ULTRA-HIGH STRENGTH STEELS, AND RESEARCH ON MATERIALS AND VARIOUS NOVEL TECHNIQUES OR FABRICATION OF HIGH PERFORMANCE ROCKET MOTOR CASES. June 1961.

AD-258588

Reactive Metals, Inc., Niles, Ohio.
A STUDY OF THE EFFECT OF ELECTRON BEAM MELTING ON COMPOUNDS AND METALS. R. L. Martin, S. R. Seagle and O. Bertea.

Electron beam melting and deoxidation studies on metals, alloys and compound including B, B-C, B-Si, TaC, TiC, ZrB_2 and Hf, W, Co, V, Be and Mo. Determination of microstructure, chemical composition, interstitial content, brittleness and tensile properties.

AD-259980

Mellon Inst. of Industrial Research, Pittsburgh, Pa.
THE EVOLUTION OF ULTRA-HIGH STRENGTH STEELS, AND RESEARCH ON MATERIALS AND VARIOUS NOVEL TECHNIQUES OF FABRICATION OF HIGH PERFORMANCE ROCKET MOTOR CASES. G. K. Bhat.

Investigation of methods and materials for lowering strength to weight ratios of pressure vessels and rocket cases includes tensile testing of three Al alloy wires; winding of pressure vessels with Al filaments bonded with epoxy resin; drawing of Be filaments; fatigue testing of vacuum-melted steel; tensile testing of welded and air-melted MX-2; ultrasonic grain refining; and determining bi-axial strengths of surface decarburized pressure vessels of Rocoloy 270, 300 M and AISI 4340.

AD-263272

Lockheed Aircraft Corp., Sunnyvale, Calif.
BERYLLIUM. A SURVEY OF THE LITERATURE. Jack B. Goldmann.

An annotated bibliography covering publications released during the first quarter of 1961. Subject headings include alloys, analysis, applications, compounds, fabrication techniques, hazards, joining, oxides, powder metallurgy and casting, processing, properties and miscellaneous.

AD-271582

Research Chemicals, Inc., Burbank, Calif.
PROPERTIES OF YTTRIUM AND THE RARE EARTH METALS OXYGEN AND ALLOY SYSTEMS. REPORT FOR OCTOBER 1959-OCTOBER 1960 ON METALLIC MATERIALS. Bernard Love. August 1961, 179p. (WADD TR 61-123) (Contract AF 33(616)6829, Proj. 7351)

Experimental studies include determination of miscibilities, O_2 solubilities and tensile strengths of rare earth alloys; measurement of solubilities of rare earths in Co, Ta and Cb; atmospheric corrosion tests of Cb and Co alloyed with rare earths; and grain refining Be by Er additions.

AFCRL-4

Denver. Univ. Denver Research Inst.
LITERATURE SURVEY OF SELECTED SEMICONDUCTOR PROPERTIES. SCIENTIFIC REPORT NO. 1. Richard W. Sullivan, Richard D. Seibel, and Charles E. Lundin. December 1960.

Data are given for distribution coefficients and solid solubilities of solute elements in Si and Ge and thermodynamic properties for Be, Mg, Ca, Sr, Ba, Ra, Sc, Y, La, Ac, Ti, Zr, Hf, V, Cb and Ta.

ANL-6426

Argonne National Lab., Ill.
ELECTRICAL PROPERTIES OF GLASS. A BIBLIOGRAPHY. Robert Kepple. July 1961, 37p. (Contract W-31-109-eng-38)

Production of ductile Be composites consisting of Be particles in a ductile matrix. Testing of composites in uniaxial compression to determine the matrix composition and heat treatment for the best mechanical properties. Canning of a Ag-6Al matrix compact in Cu and extrusion at 500°C.

ASD-TR-61-322 (p. 563-86)

Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
UNIQUE METALLIC MATERIALS AND TECHNIQUES. E. M. Kennedy, Jr. and S. A. Worcester, Jr.

Development of high static and dynamic pressure and ultra rapid quenching techniques for production of low weight, high strength and corrosion resistant Be, Sc, Y and rare earth metals.

ASD-TR-61-322 (p. 885-98)

Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
BERYLLIUM RESEARCH AND DEVELOPMENT. S.S. Christopher.

Fabrication and joining of wrought Be; evaluation of structural integrity.

ASD-TR-62-7-665
Cincinnati Univ. Kettering Lab.
TOXICITY OF BERYLLIUM. J. Cholak, R. A. Kehoe, L. H. Miller et al. April 1962, 69p.
Effects of absorption of Be by people working with Be. Details of ventilation and safety equipment for handling and processing the metal; analysis methods including spectrographic, air sampling and fluorescent techniques.

ASME Paper No. 61-PROD-12
American Society of Mechanical Engineers
A REVIEW OF METAL-PROCESSING LITERATURE – METAL CUTTING PRACTICES. J. R. Roubik, A. L. Pickrell, K. H. Moltrecht, R. L. Vaughan, J. A. Sweeney, and E. J. Weller. 1961, p. 5-7.
Tool-machine control systems, health and safety precautions during machining of Be, ...

ASTM Special Tech. Pub. 272
American Society for Testing Materials, Philadelphia.
SYMPOSIUM ON NEWER METALS. Presented at the Third Pacific Area National Meeting, San Francisco, Calif., October 15 and 16, 1959. 1960, 222p.
The symposium was conducted in three sessions. The first session, Properties of Refractory Metals, included papers on high-temperature testing methods and properties of molybdenum, tantalum, niobium, and the platinum metals. The second session, Nuclear and Light Metals, contained papers on beryllium, yttrium, and zirconium. The third session, Processing of Newer Metals, was concerned with purification and fabrication of niobium, tantalum, molybdenum, chromium, and lithium. In addition to the orally presented papers, the paper "Coulometric Determination of Tin with Electrolytically Generated Iodines: Application to Analysis of Zircaloy," is included to supplement the information given on test methods and properties of the Zircaloy alloys. Separate abstracts were prepared for thirteen papers of the fifteen papers included.

BMI-1514 (Del.)
Battelle Memorial Inst., Columbus, Ohio.
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING APRIL 1961. Russell W. Dayton and Clyde R. Tipton, Jr. May 1961.
Review of development studies for reactor materials and components; alloy and ceramic fuels; U-C; growth of UO_2 single crystals; radioisotope and radiation applications; uranium mononitrides; coated-particle fuels, recovery of spent fuel elements; fabrication processes for cold bonding Zircaloy-2 to 410 stainless steels; radiation effects on MGCR and SM-2 fuels; corrosion of U and Th; gas pressure bonding of Be-clad elements.

CEA-Note-261
France. Commissariat à l'Énergie Atomique, Paris.
NUCLEAR RAW MATERIALS. STATE OF KNOWLEDGE AFTER THE GENEVA CONFERENCE (SEPTEMBER 1958). May 1959. 214p. (French)
A condensed collection is given of information on nuclear raw materials. Most of the information comes from the Second Geneva Conference, but it is updated by extracts from more recent published literature and research reports. The geology of U, Th, Be, Zr, Li, and He

is discussed. Information is given on research methods and apparatus. Other data are given on reserves and resources, exploitation, concentration of ores, economics of nuclear materials, and applications of nuclear explosions in mining.

CU(PNPL)-203
Columbia Univ. New York. Pegram Nuclear Physics Labs.
PROGRESS REPORT FOR JANUARY, FEBRUARY, MARCH 1960 TO THE UNITED STATES ATOMIC ENERGY COMMISSION. 47p.
(Contract AT-30-1-GEN-72)
The charge exchange reaction using (He^3T) on mirror nuclei Be^9 and Li^7 was investigated.

DC-59-3-188
General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati.
BERYLLIUM RESEARCH IN THE USSR. INFORMATION BIBLIOGRAPHY. J. H. Guill and J. Woroncow, comps. March 1959. 30p.
(Contract AT(11-1)-171.
Bibliography on Be research containing 215 references.

DMIC-Memo-105
Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
REVIEW OF RECENT DEVELOPMENTS IN THE METALLURGY OF BERYLLIUM. Webster Hodge. May 1961.
A summary with emphasis on purity and mechanical and physical properties.

DMIC-Memo-123
Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
REVIEW OF RECENT DEVELOPMENTS IN THE TECHNOLOGY OF BERYLLIUM. Webster Hodge. August 1961. 3p.
Review of articles on the technology of Be, May-July 1961. Purification, casting, machining and reaction of Be with CO are noted and data presented on chemical and physical properties affected.

DMIC-Report-146
Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
MANUAL FOR BERYLLIUM PROSPECTORS. W. L. Smith. January 1961. 26p.

DMIC-Report-160
Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
INTRODUCTION TO METALS FOR ELEVATED-TEMPERATURE USE.
J. E. Campbell, H. B. Goodwin, H. J. Wagner, R. W. Douglas, and B. C. Allen. October 1961. 70p.
Mechanical and physical properties of high temperature metals for applications above 800°F. Categories include refractory, reactive and Pt-group metals, Fe, Co and Ni-base alloys, Be, Hf, Re, Al and Mg. Reactions with gases include oxidation and H embrittlement and effects of alloying and protective coatings.

DMIC-Report-165

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio

METHODS OF EVALUATING WELDED JOINTS. M. D. Randall, R. E. Monroe, and P. J. Rieppel. December 1961.

GA-1532

General Atomic Div., General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.

MARITIME GAS-COOLED REACTOR PROGRAM. QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1960. 146p. (Contract AT(04-3)-187.

Removal of a semi-homogeneous fuel element from the in-pile loop after 1000 hr irradiation. Burst tests of Inconel and Hastelloy X fuel cladding tubes at 1900°F. Determination of the Fermi age of BeO. Determination of a delayed positive coefficient of reactivity due to the build-up of Pu^{239} from calculations of the prototype reactor temperature coefficient of reactivity to 2000°F. Effects of additions of calcium oxide to UO_2-BeO bodies on the density. Effects of a He atmosphere on the properties of Inco 713C. SA302B and 316 stainless steels. Hardening of Cb-base alloys by O and N impurities in helium.

GA-1738

General Atomic Div., General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.

MARITIME GAS-COOLED REACTOR PROGRAM. QUARTERLY PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1960. 117p. (Contract AT(04-3)-187.

Determination of the operating characteristics of beryllia-moderated gas cooled systems in an experimental maritime reactor. Endurance tests of a ball-nut lead screw in hot helium. Investigation of the effects of additives on properties of UO_2-BeO diluted fuel bodies. Development of high density BeO bodies. Hot cell examination of fuel capsules to determine dimensional changes after burnup. Galling tests and creep rupture tests of weld specimens in SA302-B steel.

GEMP-103A

General Electric Co. Flight Propulsion Lab. Dept., Cincinnati

SUMMARY OF HIGH TEMPERATURE MATERIALS WORK PERFORMED IN FY 61, PT. A, MAY 1, 1961-JUNE 30, 1961. December 1961. 20p. (Contract AT(40-1)-2847.

Tests on high-temperature materials include 590-1370°C oxide spalling of Cb-Al-Ti and Cb-Al-Ti-Cr alloy rods, fabrication of FeCrY-Eu_2O_3 cermets, mechanical testing of irradiated high-temperature alloys and preparation and cladding of Y-5 wt % Cr alloy cores.

IDO-14560

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.

CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1961. J. R. Bower, Ed. 93p. (Contract AT(10-1)-205.

Aqueous Zr processing, dissolution of BeO-UO_2 ceramic fuel, the aqueous stainless steel process, the behavior of dibutyl phosphates, fluidized bed calcination, conversion of amorphous alumina to alpha lumina, waste calcining, removal of long-lived radioisotopes from waste

solutions, separation of Fe, Ni and Cr from stainless steel waste solutions, electrolytic dissolution, electrolytic disintegration of Zircaloy 2, corrosion evaluation of materials of construction.

LAMS-2382

Los Alamos Scientific Lab., N. Mex.
A BIBLIOGRAPHY OF REPORT LITERATURE ON BERYLLIUM, JANUARY 1954 – NOVEMBER 1959. Helen J. Chick, comp. November 1959. 65p. (Contract W-7405-eng-36)

A bibliography containing 237 references to report literature published between January 1954 and November 1959 is presented on the properties, metallurgy, and fabrication of beryllium.

LMSD-288140

Lockheed Aircraft Corp., Missile and Space Div. Sunnyvale, Calif.
GENERAL RESEARCH IN MATERIALS AND PROPULSION. V. 1. PROPULSION CHEMISTRY AND PROPULSION PHYSICS. January 1960, 152p.

Thermionic theory and techniques, ionic propulsion, nuclear ionic system, propellant combinations to obtain maximum burnt velocity, thermal electronic covertor design and emitter materials, phosphorous-fluorine oxidizers and lithium dinitroethane and methylenedinitramine as oxidants for high energy chemical systems.

LMSD-288140 (Vols. I and II)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
GENERAL RESEARCH IN MATERIALS AND PROPULSION, JANUARY 1959 TO JANUARY 1960. VOLUME I. PROPULSION CHEMISTRY AND PROPULSION PHYSICS. VOLUME II. METALLURGY AND CHEMISTRY. January 1960. (Vol. I, 200p. and Vol. II, 271p.)

These two volumes were issued separately, but are cataloged as a unit.

The results obtained from theoretical and experimental studies are assembled into a collection of research reports. The reports comprise a series of papers that deal with various topics in the metallurgy and chemistry of beryllium and niobium and in propulsion chemistry and propulsion physics. Separate abstracts were prepared for 9 out of 19 papers.

LMSD-288190 (Suppl. 2)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
BERYLLIUM – SURVEY OF THE LITERATURE. K. D. Carroll, comp. August 1960. 85p.

A bibliography containing 228 references is presented on the fabrication, properties, and production of beryllium, beryllium alloys, and beryllium compounds.

LMSD-288190 (Suppl. 3)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
BERYLLIUM: A SURVEY OF THE LITERATURE. Kenneth D. Carroll, comp. December 1960. 93p.

An annotated bibliography on beryllium, the third supplement to LMSD-288190, covering publications released during the final quarter of 1960 is presented. Citations are arranged alphabetically by author under the following subject headings: alloys, analysis, applications, compounds, bibliography, fabrication techniques, hazards, joining,

oxides, powder metallurgy and casting, processing, properties, and miscellaneous. References to the use of beryllium in fuels, nuclear reactor applications, effects of radiation, and Cu-Be alloys are omitted.

MAB-165-M

National Research Council. Materials Advisory Board
A REVIEW OF THE STATUS OF THE REFRACTORY METALS AND BERYLLIUM FROM THE PRODUCER'S STANDPOINT. A. V. Levy. p. 200-38.

The uses, ease of fabrication, and properties of Nb, Mo, Ta, W, and Be are reviewed relative to aero-space applications.

MIT-1113 (Del.)

Massachusetts Inst. of Tech., Cambridge. Metallurgical Project.
TECHNICAL PROGRESS REPORT FOR THE PERIOD APRIL 1953 THROUGH JUNE 1953. September 1953.

X-ray examination of the ductility and preferred orientation of cross-rolled, zone-melted, extruded powders and flat crystals of Be containing Si, Al, Cr, Fe, Ni, Cu, Mn and C. Analysis of the grain structure of water quenched U reduced and alpha extruded at high velocities. Coextrusion and bonding of Al-U tubes. Hot tensile testing and coextrusion of U-Zr alloys at various elongation rates. Determination of hardness and interface irregularities of corroded billets, rods and crystals of U. Corrosion of Zr with molten U-Cr alloys. Extrusion of Th. Preparation and study of the density, strength, shear modulus, thermal expansion, thermal conductivity and thermal shock resistance of pure Be and ternary cermets of BeO, Be, Si and Mo.

NEPA-721

Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.
REPORT ON BERYLLIUM. Walter Baxter. August 1948. 121p.
(Contract W-33-08-ac-14801(16250).)

Fabrication techniques, chemical, physical, electrical and mechanical properties of Be.

NMI-2085

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR MARCH 1960. June 1960. 39p. (Contract AT(30-1)-1565).

In the development of Be-clad U research was performed on the following: roll cladding of U-UC with Be, dimensional stability of U-UC cermet, induction melting of U-UC ingot, and extrusion cladding of epsilon U with Be. A total of sixteen vacuum-fusion samples were prepared from the cylindrical stacks and disks of the glow-discharge samples. A summary of the vacuum-fusion runs is given. Studies were made on the stability of the beta phase in U-0.3 wt% Cr-0.3 wt% Mo alloy and the determination of transformation kinetics of the U-0.3 wt% Cr alloy by measuring changes in electrical resistance during isothermal transformation of the beta phase at temperatures between 400 and 500°C. The preparation and thermal analysis are reported for Be-Pd, Be-Pt, Be-V, and Be-Ni-Pd alloys. Aging, metallographic, and x-ray data were obtained on selected samples of Be. Work is continuing to determine the order of magnitude of the isotopic interchange which would occur in dispersion-type fuel elements having a matrix of fertile material.

Two crystals of UO_2 deformed in compression at ~800°C showed strong evidence of [100] slip from analysis of the observed deformation traces. (For preceding period see NMI-2084).

NMI-2086

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR APRIL 1960. June 1960. 33p. (Contract AT(30-1)-1565).

In the Be-clad U program investigations were continued on the extrusion cladding of U-10 wt% Mo dimensional stability on thermal cycling of extrusion clad rods and melting of U-UC. Gas analysis for the glow-discharge samples is summarized. In the program to develop metastable beta-phase U-base alloys, emphasis was placed upon a study of the transformation of the retained beta phase during isothermal annealing in the temperature range 400 to 500°C. The preparation and thermal analysis of Be-Ce, Be-Cr, and Be-La alloys are reported. Values of the diffusion coefficient of U in UO_2 were calculated for two sets of experimental data in which the surface alpha counting rate was measured as a function of distance on a disc of natural UO_2 which had been heated in contact with molten enriched U at 1200°C. Three UO_2 crystals were polished, deformed, and analyzed. (For preceding period, see NMI-2085.)

NMI-2087

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR JULY 1960. August 1960. 21p. (Contract AT(30-1)-1565).

The adaptation of the honeycomb and dimpled-sheet techniques to the production of clad fuel elements is reported. Heat-treatment studies on alloys of Be with Fe, Cr, Pd, and Nb were initiated. Thermal analysis work was started on the Be-Co and Be-Mn alloy systems, and additional work was done on the Be-La system. Water quenching of pure Be and a Be-8 at. % Ni alloy from the liquid phase was tried, but no beta retention was observed. A program to study the mechanical properties of beta-phase Be-Ni alloys has begun. A number of fabrication techniques are being investigated for the fabrication of ThO_2-UO_2 fuel elements. An investigation into the mechanism of the corrosion of Zr alloys in high-temperature steam with emphasis on the role of intermetallic precipitates in the mechanism is reported.

NMI-2094

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT TO THE UNITED STATES ATOMIC ENERGY COMMISSION FOR FEBRUARY 1961. April 1961.

Investigation of hot extrusion of uranium oxide; development of honeycomb fuel elements; yttrium fabrication: U-233 recycle plant; beta-phase uranium; hydrostatic fabrication; corrosion of zirconium alloys; and beryllium metallurgy.

NMI-2095

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR MARCH 1961. May 1961.

Topics include hot extrusion of UO_2, preparation of honeycomb

fuel, yttrium fabrication, U^{233} recycle, hydrostatic fabrication, corrosion studies of Zr alloys and Be research.

NMI-2096

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT TO THE UNITED STATES ATOMIC ENERGY COMMISSION FOR APRIL 1961. June 1961.

Punching and rolling of Al-clad fuel plates of Al and U with Al-Mg cores. Metallographic examination of Zircaloy-2-clad Y following heat treatment at 900-1000°C; extrusion of billets, tube drawing and swaging techniques. Irradiation and recycling of U^{233}. Water pressure extrusion of Be billets into rods. Determination of the O gradient of steam corroded Zr alloy; crack formation in the oxide films and behavior of Zr intermetallic compounds with H_2 and O_2.

NMI-2098

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT TO UNITED STATES ATOMIC ENERGY COMMISSION FOR AUGUST 1961. November 1961. 11p. (Contract AT(30-1)-1565).

Compacting of Ru, W and Hp. Cracking in thick zirconium oxide by decoration with HCl at 700°C. Production of high purity zone-refined Be crystals with controlled orientation. Corrosion resistance comparison of the tested material.

NMI-2099

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR SEPTEMBER 1961. December 1961. 13p. (Contract AT(30-1)-1565).

Study of high temperature properties of refractory metal alloys, corrosion of Zr alloys, irradiation behavior of meta-stable beta-phase uranium and monocrystal deformation in zone-refined Be.

NMI-2101

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT, NOVEMBER 1961. January 1962. 14p. (Contract AT(30-1)-2784).

Experimental studies include corrosion of ZrO_2-coated Zr and Zircaloy-2 by HCl; irradiation-induced swelling of alpha- and beta-phase uranium in the unalloyed state, in U-0.3 wt% Cr and in U-0.3 wt% Cr-0.3 wt% Mo; and preparation and analysis of Be single crystals.

NMI-2102

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT TO UNITED STATES ATOMIC ENERGY COMMISSION FOR DECEMBER 1961. February 1962. 19p. (Contract AT(30-1)-2784).

Conversion of unalloyed Mo arc cast ingots into a wrought form by a two-temperature technique. Preparation of Mo-Re, Nb-Re, Ta-Re and W-Re alloys for hardness measurements. Investigation of two mechanisms of Zr corrosion: failure of thick oxide films and incorporation of foreign ions into the oxide lattice. Evaluation of the relative

irradiation induced swelling characteristics of alpha and beta phase uranium. Zone-refining operations on Be crystals for use in studies of prism plane slip.

NMI-9502

Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT FOR THE PERIOD APRIL 1, 1960 TO JUNE 30, 1960. S.H. Gelles. July 1960 25p. (Contract AF 33(616)-7065).

The objective of this program is to conduct a program, aimed at making beryllium useful as a structural material. There are three major categories in this program: (1) purification, (2) joining, and (3) flow and fracture. The philosophy behind these programs is twofold: first, to increase the usefulness of beryllium by advancing the technology of the material and by understanding the process and metallurgical factors involved in this technology; second, to improve present-day beryllium purification, working, heat treatment, and alloying. Within the three major categories are 12 projects, approximately 40% of which are to be carried out at NMI, the remaining 60% to be subcontracted. A list of these projects and the sites at which they will be carried out is given.

NMI-9512

Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT FOR THE PERIOD, JANUARY 1, 1961 THROUGH MARCH 31, 1961. S.H. Gelles. July 1961.

Topics include preparation by iodide decomposition method, ultrasonic welding, the role of voids and oxides, distillation, evaluation of products, aging and strain aging and raising the yield strength.

NP-8380

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS, DECEMBER 1, AND 15, 1959. M.J. Wahll, comp. 78p.

A collection of 124 abstracts of technical papers on Ti, Be, B, Mo, Ta, W, steels, stainless steel, nickel and cobalt alloys, nonmetallic refractories, and coatings is given.

NP-8752

Battelle Memorial Inst., Columbus, Ohio
DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. M.J. Wahll, comp. May 1960. 129p.

A current listing of selected documents and journal articles is presented on light metals, titanium, beryllium, boron, refractory metals, molybdenum, niobium, tantalum, chromium, tungsten, the platinum group, steels, and high-strength alloys. Also included are listings of reports of special metal applications, coatings, fabrications, nonmetallic refractories, properties, and thermal protection.

NP-9014

Battelle Memorial Inst., Columbus, Ohio
DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. M.J. Wahll, comp. June 1960. 142p.

Abstracts are presented on properties, applications, and fabrication of Ti, Be, Mo, Nb, Ta, Cr, W, steels, stainless steels, Ni alloys,

Co alloys, and high-strength alloys. Abstracts are included on coatings, fabrications, and applications of nonmetallic refractories.

NP-9106

Battelle Memorial Inst., Columbus, Ohio
DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. M. J. Wahll, comp. July 1960. 187p.

A current listing of selected documents and journal articles is presented on light metals (Ti, Be, and B), refractory metals (Mo, Nb, Ta, Cr, and W), the platinum group, steels, and high-strength alloys. Also included are listings of reports of special metal applications, coatings, fabrications, nonmetallic refractories, properties, and thermal protection.

NP-9606

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS, SEPTEMBER 1960. M. J. Wahll, comp. 193p.

A listing of selected, acquired articles, reports, and papers concerning Ti, Be, B, Mo, Nb, Ta, Cr, W, V, Re, steel, and stainless steel is presented. Author and subject indexes are included.

NP-9861

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. M. J. Wahll, comp. October 1960. 199p.

A listing of about 600 selected articles, reports, and papers concerning Ti, Be, Mo, Nb, Ta, Cr, W, V, Re, Pt, steel, stainless steels, and alloys is presented. Author and subject indexes are included.

NP-9900

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. M. J. Wahll, comp. November 1960. 115p.

A total of 184 references with appended abstracts is given on metals. Some of the metals included are titanium, beryllium, refractory metals, and high-strength alloys. Fabrication of these metals and their applications are treated.

NP-10640 (Suppl. 1)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
BERYLLIUM: A SURVEY ON THE LITERATURE, APRIL-JULY 1961. SUPPLEMENT I. Jack B. Goldmann, comp. October 1961. 116p. (SB-61-35 (Suppl. I)) (Contract NORD 17017).

Annotated bibliography on Be and Be alloys including analysis, applications, fabrication techniques, joining, mineralogy, powder metallurgy, casting and properties.

NP-11196 (p. 16-20)

Canadian Westinghouse Co., Ltd., Hamilton, Ont.
RESEARCH AND DEVELOPMENT IN NUCLEAR METALS. M. J. Lavigne.

Welding and static corrosion of Zircaloy-2; dynamic corrosion of nitrogen-contaminated Zircaloy-2; fabrication of 3 in. thick walled stainless steel vessel, joints between Zircaloy-2 and stainless steel, Be

research, effects of hydriding on the mechanical properties of Zircaloy-2 foil and brazing of Zircaloy-2.

NP-11196 (p. 34-41)

Atomic Energy of Canada Ltd., Chalk River, Ont.
MATERIALS RESEARCH AND DEVELOPMENT AT AECL. W. M. Campbell.

Creep in Zr alloys; high strength Zr alloy development effects of neutron irradiation on the mechanical properties of Zircaloy-2; hydriding Zr alloys; thermal diffusion of hydrogen in Zircaloy-2; use of tritium as tracer for studies of hydrogen in metals; study of boron distribution in metals by neutron activation; radiation effects on precipitate particles in metals; irradiation of ferritic irons and steels, effects of neutron irradiation of Cu-Be alloys, self-diffusion in single crystals of alpha uranium; electron microscopy of irradiated metal foils.

NP-tr-564 (p. 1-127)

RARE METALS AND THEIR ALLOYS. A. N. Zelikman and I. P. Kislyakov.

A review of selected properties, applications, metallurgical techniques, joining methods and cleaning of Be, Mo, Cb, Ta, W, Zr and their alloys and oxidation and thermal properties for V alloys.

ORNL-TM-1

Oak Ridge National Lab., Tenn.
QUARTERLY PROGRESS REPORT FOR CHEMICAL DEVELOPMENT SECTION B, APRIL-JUNE 1961. R. E. Blanco. November 1961. 92p. (Contract W-7405-eng-26).

Research reports on graphite fuels, UC, Be and BeO, volatilization of chlorides with H_2O_2, acid thorex process, extraction of U from Zr fuel solutions, extraction of Cb with TBP separation of Th from U^{233} by ion exchange, corrosion studies, waste fixation in borate and phsophate glasses, low level waste treatment, fission product recovery by ion exchange and radiation damage to ion exchange resins.

ORNL-3160

Oak Ridge National Laboratory. U. S. Office of Technical Services.
METALLURGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1961. 209p.

Areas of research include nondestructive testing of thin metal sections, theory of alloying, X-ray studies of crystalline defects, structure of metals and X-ray diffraction.

PB-161811

Lockheed Aircraft Corp. U. S. Office of Technical Services.
BERYLLIUM: A SEARCH OF THE LITERATURE 1957-1959. K. D. Carroll. January 1960. 113p.

The fields of Be metallurgy, crystallography, fabrication methods and the application of Be to aircraft and missiles are reviewed. Also included are references on the toxicology of Be, its hazard limits and means of detection.

PB-161812

Lockheed Aircraft Corp. U. S. Offices of Technical Services.
BERYLLIUM: A SURVEY OF THE LITERATURE. K. D. Carroll. April 1960. 59p.

Literature on Be published in the period 1957 is surveyed and listed. Each entry carries a short abstract of the contents.

PB-171083

Nuclear Metals, Inc. (Wright Air Development Division). U.S. Office of Technical Services

BERYLLIUM RESEARCH AND DEVELOPMENT IN THE AREA OF COMPOSITE MATERIALS. J. Greenspan. July 1960. 121p.

Studies of the bend ductility of Be sheets designed for sample width and thickness show that the amount of ductility is sensitive to grain orientation as well as to the sample dimensions. In narrow samples (small width/thickness ratio), bend ductility is highest with a highly preferred basal plane texture.

PB-171809

Cryogenic Engineering Laboratory, National Bureau of Standards. (Ballistic Missile Div.). U.S. Office of Technical Services

CRYOGENIC MATERIALS DATA HANDBOOK. T. F. Durham. September 1961. 555p.

Covers the field of cryogenics from 1940 through 1959 and includes some previously unpublished laboratory test data. Information on Al, Co, Cu, Fe, Ni, Ti, carbides, nonmetals (such as ice, mylar and teflon), Be and Mo. Properties range from yield strength through expansivity to mechanical hysteresis.

PB-171795

Naval Ordnance Lab., White Oak, Md.

BERYLLIUM, ACTUAL AND POTENTIAL RESOURCES, AND PROPERTIES IN RELATION TO ITS USE IN PROPELLANTS AND EXPLOSIVES. Russell McGill.

The effects of mining and extraction techniques and allocation of the ores on future supplies and their use in explosives or propellants.

SB-413

Office of Technical Services, Washington, D. C.

BERYLLIUM (1945-1960). OTS SELECTIVE BIBLIOGRAPHY. June 1960. 19p.

This bibliography includes about 225 references on beryllium. The references are arranged in sections for beryllium metal, alloys, carbides, other compounds, isotopes, and safe handling. The period covered is 1945 to 1960.

TID-7603

U.S. Atomic Energy Commission

URANIUM CARBIDE RESEARCH AT THE OAK RIDGE NATIONAL LABORATORY. Paper from URANIUM CARBIDE MEETING, PROCEEDINGS. T. Hikido. 1960. p. 107-113.

Review of research aimed at the application of bulk uranium monocarbide in gas-cooled reactor fuel elements including techniques for arc melting and casting of UC, irradiation studies, use of U_3Si_2 for liquid phase sintering of UC, compatibility of UC and Be, volatility of UC at elevated temperatures, reaction of UC and UC_2 with moisture in the air and high temperature transformation of UC_2.

USBM-U-819

Bureau of Mines. Albany Metallurgy Research Center, Ore.
QUARTERLY METALLURGICAL PROGRESS REPORT NO. 10 FOR THE PERIOD OF JANUARY 1, 1961 TO MARCH 31, 1961.

Topics include preparation of high purity Th metal; evaluation of boron nitride as a crucible material for the Mg reduction of UF_6; recovery of enriched Hf from an enriched solution containing 10% Hf; metallographic and parametric analyses of Hf-Ta and metallographic and melting point studies of Hf-V alloys; investigation of the Fe-Gd, Ni-Gd and Cr-Gd phase diagrams; welding tests on cast and rolled Ta; and casting of Zr and Mo.

WADC-TR-59-29 (Pt. II)

Brush Beryllium Co., Cleveland
AN INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. Robert M. Paine, A. James Stonehouse, and Wallace W. Beaver. February 1959. Project No. 7308, Task No. 73029. Delivery Order 33(616)-56-12.

Preparation, fabrication and properties of intermetallic compounds under development for service at temperature ranging from 2300-3000°F. The compounds, principally beryllides, are prepared by solid-state reactions and fabricated chiefly by hot pressing techniques. Oxidation tests in dry air at 2500-3000°F and in moist air (57°F dew point) at 2300-2500°F.

SECTION V. BERYLLIUM METALLURGY

PART B. ORE AND RAW MATERIAL PREPARATION

Brison, Robert J.
MINERAL PROCESSING RESEARCH. Mining Congress Journal, (Annual Review, 1961), v. 48: 53-56 (Feb. 1962)
Trends in the processing minerals by separation; froth flotation by radioisotopes, irradiation on grinding balls for ores and automatic analysis techniques. Materials considered are U ore, Ni, Cu, Co, Sn, Be, Cb, Mn and Cr.

Chopey, N. P.
PURE BERYLLIUM VIA THE FLUORIDE PROCESS. Chemical Engineering, v. 67: 82-85 (Oct. 1960).
Processing of beryl ore into Be ingots by precipitation with NaOH, slurrying with Ammonium bifluoride, vacuum salting and reduction with Mg. Ingots are vacuum cast to remove impurities.

Hochstetter, Friedrich
PRODUCTION OF BERYLLIUM. Chemiker-Zeitung, v. 86: 108-109 (Feb. 1962) (German)

Hotchkiss, Eugene B.
BERYLLIUM. Mining Congress Journal (Annual Review, 1961), v. 48: 105-107 (Feb. 1962)
Research on the mining, extraction and production of Be, beryllides and barylite. Review of potential applications and fabrication methods.

Hyde, K. R., P. L. Robinson, M. J. Waterman and J. M. Waters.
REACTION OF BERYL WITH SODIUM FLUORESILICATE USED IN EXTRACTING BERYLLIUM FROM THE MINERAL. The Institution of Mining and Metallurgy Bulletin, v. 70: 397-406 (April 1961)

Knoerr, Al. and Mike Eigo
BERYLLIUM UPDATE - 1961. Engineering and Mining Journal, v. 162: 87-97 (Sept. 1961)

Kobrin, C. L.
SCRAP PROCESSING GOES MODERN. Iron Age, v. 190: no. 4, 68-70 (July 1962)
Identification, sorting, processing and packaging of beryllium, copper, lead, titanium, and nickel alloys.

Mazhiborskaya, Kh. B.
RADIOACTIVATION METHOD FOR THE DETERMINATION OF BERYLLIUM IN MINERAL RAW MATERIALS AND IN HYDROMETALLURGICAL PRODUCTS. Journal of Inorganic Chemistry, v. 15: 323-328 (May-June 1960) (Russian)
The determination of Be by a radio activation technique with attention to control of effects distorting analytical results because of self-absorption of photoneutrons and gamma-ray absorption.

Plaksin, I. N. and V. I. Solnyshkin

THE EFFECT OF CAUSTIC SODA ON BERYLLIUM MINERAL SURFACE WHEN PREPARING IT FOR FLOTATION. Izvestiya VUZ-Tsvetnaya Metallurgiya, 28-35 (Mar. 1961) (Russian)

Use of infrared spectroscopy to study the surface structure of Be, rutile, ilmenite, Zr and magnetite ore particles treated by caustic soda and deposited on NaCl plates.

Saraev, V. P. and E. A. Samkov

COLLECTION OF Re FUMES DURING ROASTING OF Be CONCENTRATES. Tsvetnye Metally, no. 12: 53-60 (Dec. 1960) (Russian)

Comparison of methods for recovery of Re during Be concentrate roasting including foaming, scrubbing, bubbling and electrofiltration. Efficiency of various apparatus combinations.

Wroten, William L.

REFRACTORIES RESIST MORE THAN HEAT. Chemical Engineering, v. 69: 158-163 (June 1962)

Properties and applications are received for refractories, including thermal conductivity, rupture modulus, thermal expansion coefficient, melting point, wear resistance, refractoriness, permeability, porosity and abrasion, chemical and spalling resistance; selection criteria and application in industry.

Chemical & Engineering News, v. 39, June 26, 1961, p. 21-22.

SPACE USES PUSH BERYLLIUM DEVELOPMENT.

The concentration of domestic low grade Be ores is discussed in its commercial applications in nuclear, electronic, and missile industries. Domestic and foreign sources of Be ores are reviewed.

Mines Magazine, v. 52, Feb. 1962, p. 7.

BERYLLIUM CONCENTRATES MILL OPENED IN BODGER FLATS AREA.

Mining Engineering, v. 13, Oct. 1961, p. 114-1145.

MINCON EMPLOYS PELLETIZER TO BENEFICIATE BERYLLIUM ORE.

Low grade Be ore is crushed, upgraded by flotation, dried, fused into pellets and sintered to provide BeO concentrates of 90% purity. Process mechanics and plant layout for Mincon beneficiating process.

Mining Engineering, v. 14, Feb. 1962, p. 69-75.

MINERALS BENEFICIATION IN 1961.

Review of developments in autogenous crushing and grinding, screening, flotation, smelting, segregating, leaching, electrolysis, ion exchanging, pelletizing, magnetic separating, washing, classifying, cleaning, defoaming, filtering, thermal decomposing, crystallizing, roasting, solvent extraction and H_2 reduction of Fe, Cu, Pb, Zn, Kaolin, bauxite, cation, resin, potash, phosphate, beryl, pegmatite, V_2O_5, Mo, Fe_3O_4, Fe_2O_3, Cr, Co, Ta, perlite, $Al_2(SO_4)_3$ and Sc. Data are given for concentration, recovery, separation and particle size of ore.

BM-RI-5767

U.S. Bureau of Mines, Report of Investigation 5767.
FLOTATION OF BERYL FROM NORTHEASTERN PEGMATITES.
J.E. Shelton. 1961, 10p.

Direct, cationic and anionic flotation of ground pegmatites containing 43-1.16% BeO using reagents of H_2SO_4, NaOH, HCl, NaF, H_2SiF_6, HF and acetic acid.

BM-RI-5875

U.S. Bureau of Mines, Report of Investigations 5875.
FLOTATION OF BERTRANDITE AND PHENALITE FROM MOUNT WHEELER, NEVADA, BERYLLIUM ORE. Richard Havens, W.I. Nissen and J.B. Rosenbaum. 1961, 14p.

The Be minerals are conditioned and floated from undeslimed pulps at natural pH using sodium fluoride and sodium hexametaphosphate as modifiers and a fatty acid-fuel oil combination as the collector at 28-45°C. Influence of grinding time and size, type of water, pulp solids, temperature and sequence and quantity of modifying reagents on efficiency of Be recovery.

CEA-1568

Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France.
METHOD OF SEMIQUANTITATIVE DETERMINATION OF BERYLLIUM IN ROCKS AND SOILS BY PAPER CHROMATOGRAPHY. H. Agrinier. Dec. 1960. (French)

DMIC Report 146

Battelle Memorial Institute.
MANUAL FOR BERYLLIUM PROSPECTORS. W.L. Smith. Jan. 18, 1961, 26p.

Likely geological environments and means of detecting Be deposits in the field. Economics and technology of Be production. Composition, location and applications of Be minerals.

Patent - British 878,390

IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF BERYLLIUM. Leslie Jack Derham (National Smelting Co., Ltd.) Sept. 27, 1961.

Production of Be by beryllium fluoride in Mg reaction. Mixture is briquetted, densified and heated in contact with a fusible salt.

Y-1328

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
BERYLLIUM CHIP PROCESSING. Z.L. Ardary, W.C. McWhorter, J.W. York, J.E. Perry, F.M. Tench, and P.B. Petretzky. Dec. 15, 1960, 43p. (Contract W-7405-eng-26)

A process was developed for upgrading beryllium chips contaminated with cutting oils and metallic and nonmetallic trash. Investigations were conducted on grinding of these chips to mesh sizes as low as -200 mesh utilizing attrition milling, fluid energy milling, or planetary ball milling. This entire process adds no significant impurities other than oxygen. The beryllium oxide content of the powders increases no more than 0.50% over that present in the original chip.

SECTION V. BERYLLIUM METALLURGY

PART C. EXTRACTING AND REFINING

Amonenko, V. M., G. F. Tukhunskii, V. A. Finkel', V. M. Azhazha, and I. V. Shpazin
PLASTIC DEFORMATION OF TEXTURED BERYLLIUM. (Translated from Fizika Tverdogo Tela, v. 3, Mar. 1961) Soviet Physics - Solid State, v. 3: 580-584 (Sept. 1961)

Berger, G. S. and I. I. Levin (Izvestyia Akademii Nauk SSSR)
EXPERIMENTAL SEPARATION OF TANTALITE CONCENTRATES IN CAPACITOR WITH LIQUID DIELECTRIC. OTN, Metallurgiya i Toplivo, 115-117 (Apr. 1961) (Russian)
Determinations of heterogeneous electric field between two charges with polarization of mineral particles and ponder-motive attraction force.

Blanco, R. E.
RECENT ADVANCES IN AQUEOUS PROCESSES. American Nuclear Society, Transactions, v. 4: 187-192 (Nov. 1961)
Developments in dissolution and extraction of Th, Pu and U fuels from graphite and stainless steel based fuels, UC, $BeO-UO_2$, U-Mo alloys, UO_2 clad with Zircaloy and Zr. These are processed, dissolved, recovered, hydrolyzed and treated by solvent extraction methods, dejacketed, electrolytically dissolved and processed amine extraction for recovery.

Chauvin, G., H. Coriou and J. Hure
ELECTROREFINING OF NUCLEAR METALS IN A MOLTEN SALT BATH. Metaux Corrosion-Industries, v. 37: no. 439, 112-126 (Mar. 1962) (French)
Industrial electrorefining of commercial uranium, beryllium, plutonium, thorium and titanium by chloride and fluoride salt electrolytic baths. Determination of the influence of humidity and concentration of electrolyte on resulting purity.

Chopey, N. P.
PURE BERYLLIUM VIA THE FLUORIDE PROCESS. Chemical Engineering, v. 67: 82-85 (Oct. 1960)

Gilles, Paul W.
HIGH TEMPERATURE CHEMISTRY OF THE BINARY COMPOUNDS OF BORON. Borax to Boranes — Advances in Chemistry Series, American Chemical Society, no. 32: 53-59 (1961)
Review of preparation by synthesis or reduction; properties including melting and boiling points, conductivity, solubility, chemical inertness and thermodynamic stability; phase relationships; and uses, with reference to metallic-refractory borides.

Goosey, R., R. A. Knight and A. J. Martin
THE INDUCTION MELTING AND CASTING OF BERYLLIUM. Less-Common Metals, Journal, v. 4: 199-212 (Apr. 1962)
Study of the defects normally found in vacuum-cast, induction melted Be ingots. The defects, including segregation, gas porosity and cold shuts, are classified according to metal source and their elimination is shown to be dependent upon conditions of casting such

as teeming temperature, rate of pour and pretreatment of the raw material in tests on electrolytic flake and thermally reduced Be.

Hochstetter, Friedrich
PRODUCTION OF BERYLLIUM. Chemiker-Zeitung, v. 86: 108-109 (Feb. 1962) (German)
Fluxing of $BeO \cdot Al_2O_3 \cdot 6SiO_2$ — containing ores by sintering with Na_2SiF_6 at 750°C to obtain water-soluble Na_2BeF_4. Extraction of Be by leaching and precipitation as Be $(OH)_2$. Production of Be alloys in arc furnaces and of pure Be by reduction of BeO by Na or Mg or by electrolysis of $BeCl_2$.

Hotchkiss, Eugene B.
BERYLLIUM. Mining Congress Journal (Annual Review, 1961), v. 48: 105-107 (Feb. 1962)

Hyde, K. R., P. L. Robinson, M. J. Waterman and J. M. Waters
REACTION OF BERYL WITH SODIUM FLUOROSILICATE USED IN EXTRACTING BERYLLIUM FROM THE MINERAL. The Institution of Mining and Metallurgy, Bulletin, v. 70: 397-406 (April 1961)
An analysis of the chemical reaction of beryl with sodium fluorosilicate and its decomposition products, sodium fluoride and silicon tetrafluoride. Results of tests to determine the effects of roasting temperature and time, atmospheres and beryl particle size on the Be extraction rate and on the formation of sodium fluoroberyllate glass, cryolite, A-cristobalite and albite.

Ivanov, V. E., V. M. Amenko, G. F. Tikhinsky and A. A. Kruglykh
REFINING OF BERYLLIUM BY VACUUM DISTILLATION. Fizika Metallov i Metallovedenie, v. 10: 581-585 (Apr. 1960) (Russian)
Production of high purity Be (99.987%) using vacuum distillation method with condensation of vapors on the heated surface at 900-1200°C. Hardness measurements for Be of various purities. Reduction of plasticity attributed to presence of oxygen and carbon in produced metal.

Pruvot, Emile
PRODUCTION OF BERYLLIUM AND ITS ALLOYS. WORK OF PAUL LEBEAU. PRESENT PROCESSES. Bulletin de la Societe Chimique de France, 172-176 (Jan. 1961) (French)
Production of crude Be. Purification by fractionated sublimation and electrolysis to produce highly purified Be.

Meerson, G. A.
ASPECTS OF THE METALLURGY OF URANIUM AND CONSTRUCTIONAL METALS. Soviet Journal of Atomic Energy, v. 6: 69-72 (Sept. 1960) (Translation - ConBur.).
Methods of uranium production including reductive melting, casting, pressure treatment and powder metallurgy; Zr metallurgy including new data on the technological scheme, nature of sponge and dimensions of ingots; production of the new constructional metals, Cb and V by metallothermal, vacuum carbothermal and electrolytic refining; production of Be tubes for fuel elements sheaths; use of Zr hydride as a moderator and of Zr, U and H alloys for fuel element cores.

Miller, A. B.
LEVITATION MELTING OF BERYLLIUM. Journal of Nuclear Material, v. 5: 344-346 (Apr. 1962)
Review of principles and mechanisms of levitation melting. Application to spherical powder metal compacts of Be with heating temperatures attained of 1640°C. Analysis of resultant microstructure and impurity segregation phenomena as a function of size and shape of specimen and process variables.

Mitchell, W. R., J. A. Mullendore and S. R. Maloof
ZONE PURIFICATION OF BERYLLIUM. Metallurgical Society of AIME, Transactions, v. 221: 824-826 (Aug. 1961)
Metallic impurities of Al, Fe and Si and BeO as found in commercially pure hot pressed Be powder are experimentally reduced to lower concentrations by zone-purification techniques. Reduction in the concentration of Al to extremely low levels (10 ppm.) is noted, Al being considered a major factor contributing to the hot tearing of Be during fusion welding. A method is suggested for producing Be of improved weldability by zone melting.

Newkirk, Arthur E.
PREPARATION AND CHEMISTRY OF ELEMENTARY BORON. Paper from "Borax to Boranes". Advances in Chemistry Series, ACS, No. 32: 27-41 (1961).

Nichkov, I. F. and M. V. Smirnov
ELECTROLYTIC EXTRACTION OF BERYLLIUM AND ZINC AT TEMPERATURES BELOW 1000°C. Izvestiya VUZ – Tsvetnaya Metallurgiya, 105-107 (Mar. 1961) (Russian)
Interaction of Be and Zn at temperatures below 1000°C. in a closed electrolyzer with an electrolyte consisting of chlorides of Be, Ca and Na and a Zn electrode.

Nijhawan, B. R.
THE ROLE OF THE NATIONAL METALLURGICAL LABORATORY IN RESEARCH AND DEVELOPMENT OF LIGHT METAL INDUSTRY IN INDIA. NML (National Metallurgical Laboratory) Technical Journal, v. 3: 56-72 (Feb. 1961).
Developments in the production of Al, Ti, Mg, Be, Zr, Al-Si alloy and Al-Mg alloy from bauxite, ilmenite, magnesite, dolomite, beryl and zircon respectively by electrolytic extraction, chlorination, reduction and catalytic distillation. Tensile strengths and corrosion resistances given.

Pfann, W. G.
ZONE MELTING. Science, v. 135: 1101-1109 (Mar. 1962)
Description of process and equipment for zone melting, zone refining, zone leveling and temperature gradient zone melting of semiconductors, refractory metals and low melting point metals for high purity or controlled compositions. Mathematics are given for zone refining.

Pohodin-Alexeen, H. I., V. M. Havrilon and F. V. Korolev
USING LOW-FREQUENCY VIBRATIONS DURING CONTINUOUS CASTING OF BERYLLIUM BRONZE. Tsvetnye Metally, no. 4: 69-73 (1962) (Russian)

Continuous casting of induction melted BrB-2.5 and BNT bronze using graphite crucibles and eccentric vibrators during melt crystallization using eccentric vibrators. Determination of the ingot structure, and effect of the vibration amplitude and frequency on hardness, brittleness and microstructure.

Popov, B. E., S. F. Kovtun and V. M. Amonenko
REDUCTION OF GRAIN SIZE IN BERYLLIUM AND CHROMIUM BY EXPOSURE TO ULTRASOUND DURING ARC MELTING. Fizika Metallov i Metallovedenie, v. 10: 853-856 (Dec. 1960) (Russian)
Arc melting of a Be or Cr electrode in an Ar atm of 400 mm pressure with and without simultaneous exposure to ultrasonic vibrations of 10-30 kcps frequency. Comparison of microstructures obtained.

Runnalls, O. J. C.
STUDIES ON PLUTONIUM AT CHALK RIVER. Chapter 7 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Illinois, 1961, p. 70-78.

Runnalls, O. J. C.
THE PREPARATION OF PLUTONIUM-ALUMINUM AND OTHER PLUTONIUM ALLOYS. Chapter 26 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Illinois, 1961, p. 309-330.
Thermodynamic data, particularly heats (298°K) and free energies (298-1500°K) of formation, for reactive metal oxides and oxides are applied to preparation of binary Pu alloys with Al, Th, U, Be, Al, Ga, In, Tl, Si, Mg and Ca by reduction of the fluoride or oxide by an excess of the metal.

Sawamoto, Hachie, Takeo Oki and Akira Nishina
A STUDY ON METALLURGY OF METALLIC BERYLLIUM REDUCING BERYLLIUM OXIDE WITH CALCIUM. Nagoya University, Faculty of Engineering, Memoirs (Japan), v. 12: 130-135 (May 1960)
Reduction with excess Ca yielding a Ca-Be alloy from which the Be is extracted by removal of Ca and CaO with NH_4Cl, the product being Be powder of high purity.

Scaife, D. E. and A. W. Wylie
THE PREPARATION OF THORIUM CARBIDE AND SOME ASPECTS OF THE HIGH TEMPERATURE DECONTAMINATION OF IRRADIATED CARBIDE FUELS. Australian Atomic Energy, Symposium, 1958, p. 172-181.
A study is made of factors influencing the synthesis of ThC_2 from ThO_2 and C and the volatilization of Be, Cd, Ce, Eu, Fe, Nb, P and Sr from ThC at 2150°C. Radiometric, colorimetric, fluorimetric, and flame photometric techniques are used to follow the volatilization of impurity elements from the caribde above 2000°C.

Schofield, M.
A CENTURY OF BERYLLIUM AND MAGNESIUM EXTRACTION. Metal Treatment and Drop Forging, v. 29: 233-236 (June 1962)
Historical review of extraction processes for Be and Mg compounds including electrolysis and reduction by Na, Mg, CaC_2, C and ferrosilicon.

Schofield, M.
A CENTURY OF SODIUM REDUCTION PROCESSES. Metallurgia, v. 65: 21-24 (Jan. 1962)
Review of production procedures including extraction, leaching, distillation, electrolysis, precipitation and purification of Al, Mg, Be, Ti and Zr chlorides utilizing Na and K as reduction agents.

Sharples, J. T.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 314-317 (Oct. 1961)
Melting, heat treating, soldering, welding, zone refining, crystal pulling and die casting using induction and indirect resistance heating.

Sharples, J. T.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 361-364 (Nov. 1961)
Vacuum processes for melting and heating of Cu wire, Nimonic and other Ni alloys, Be, Ti, Zr, Mo and W include bright annealing, brazing, casting, degassing and melting. Design and operating principles of resistance and induction vacuum and vacuum arc furnaces.

Sharples, J. R.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 383-384 (Nov. 1961)
Electron beam heating is applied to vacuum welding, zone refining, cold mold induction, vacuum induction melting and brazing. Use of electron beam melting in purification of Ni, Be, Ta, Cb, Mo, Ti and Zr alloys, superalloys and special steels.

Silina, G. F. and L. L. Grinberg
ELECTROLYTIC REFINING OF Be. Tsvetnye Metally, 47-53 (Dec. 1960) (Russian)
Electrolytic purification of Be using Be anodes, Ni cathodes and a $KCl-BeCl_2-NaCl$ electrolyte. Dependence of Be purity on per cent BeCl and purity of electrolyte. Effect of current and electrolysis time on amount of Be refined.

Smirnov, M. V.
RESIDUAL CURRENTS AND CATHODIC DEPOSITION OF METALS FROM MOLTEN SALTS. Electrochemistry of Molten and Solid Electrolytes, no. 1: 3-5 (1961) (Translation-ConBur.)
Derivation of an expression for the cathodic yield (limiting residual current) as a function of temperature and metal ion concentration during electrolysis of molten Be, Th, Ti, Zr, Hf, Th, U, Cb and Ta salts.

Smith, Gordon B. and Patrick A. Tully
CONTROLS CUT COSTS OF COPPER-BASE ALLOY MELTING. Foundry, v. 89: 72-74 (Dec. 1961)
Design and operation of a direct reading spectrograph and an induction furnace installation which melts and alloys Cu with other metals under controlled analysis of melt samples before pouring. Method of preparing the melt sample for anlaysis is discussed with composition given for the cast Cu alloy billets.

Still, J. E.
THE DETERMINATION OF GASES IN METALS BY VACUUM FUSION. Paper from DETERMINATION OF GASES IN METALS. Iron and Steel Institute, London, England, 1960, p. 43-63.
"Gas contents of Ti, Zr, Mo, in Be etc. . . . "

Syre, R.
VACUUM MELTING OF SOME NONFERROUS METALS. Revue de Metallurgie, v. 57: 1107-1116 (Dec. 1960) (French)
Consumable-electrode, skull-melting and electron-bombardment vacuum melting of Be, Ti and Zr (reactive metals) and Nb, Mo, Ta and W (reactive and refractory metals).

Townhill, A.
BERYLLIUM DESCRIBED AS TRUE SPACE AGE METAL. Metals Review, v. 34: 22-23 (Jan. 1961)

Treybal, Robert E.
LIQUID EXTRACTION. I & EC (Industrial and Engineer-Chemistry), v. 54: 56-60, 62 (May 1962)
Literature survey up to Dec. 1, 1961, covers extraction techniques making use of mixer-settlers, spray towers, packed towers, perforated plate towers, pulsed columns and rotating disk columns.

Tyler, Paul M.
PLASMA FOR EXTRACTIVE METALLURGY. Journal of Metals, v. 13: 51-54 (Jan. 1961)
Physical properties of plasmas (ionized gases), description of devices for generating them, and a summary of their technological uses. Results of research utilizing plasma jets in refining Fe, Al, Mg, Mn, Be, Si, B, Ti, Zr, Cb and Ta by thermal decomposition, vapor-phase halogenation, vapor-phase carbothermic reduction and liquid-phase carbothermic reduction.

Wright, J. C.
METALLURGY IN NUCLEAR POWER TECHNOLOGY. Pt. 5. FUEL ELEMENT CANNING MATERIALS. Metal Treatment and Drop Forging, v. 27: 511-517 (Dec. 1960)
Extraction and refining, melting and casting, powder metallurgy and fabrication of Be and Cb.

American Institute of Mining, Metallurgical, and Petroleum Engineers, Transactions, v. 220: 420-423 (1961)
FLOTATION OF SPODUMENE-BERYL ORES.
Evaluation of flotation procedures for concentration and recovery of BeO and Li_2O from North Carolina segmatites.

Chem. & Process Eng. 41: 32-3 (Jan. 1960)
METALS FOR THE NEW AGE. I. C. I. ADDS WROUGHT BERYLLIUM TO ITS PRODUCTION OF 'NEW' METALS.

Iron and Steel Institute, London, England, 1960, p. 64-74
THE DETERMINATION OF GASES IN METALS BY THE SEMI-MIDRO VACUUM FUSION TECHNIQUE. Paper from DETERMINATION OF GASES IN METALS.
Determination of oxygen, etc. , in. . . Be by a semi-micro fusion tech. . . . . .

Journal du Four Electrique, v. 66: 98-99 (Mar. 1961)
BERYLLIUM. (French)
Preparation of metallic Be from its ore by leaching, fusion at 1625°C, quenching, reaction with H_2SO_4, roasting at 1700°C, reaction with a fluorine compound from 700-1000°C, dissolution of the fluoberyllates in water and precipitation of Be hydroxide with NaOH or reaction with Cl in the presence of C. The Be chloride formed is electrolyzed in the presence of NaCl at 320°C.

Mining Engineering, v. 14: 69-75 (Feb. 1962)
MINERALS BENEFICIATION IN 1961.

Missiles and Rockets, v. 8: 15 (Apr. 1961)
BREAKTHROUGH: BERYLLIUM PROVED INHERENTLY DUCTILE.

Teknisk Tidskriff, v. 91: 387-389 (Apr. 1961)
BERYLLIUM PREPARATION BY THE SULPHIDE PROCESS. (Swedish)
Precipitation of heavy metals such as Cu, Ni and Fe in Be-containing materials by ammonium sulphide with an ammonium-beryllium compound crystallizing at 50°C. The ammonium is driven off at 900°C in an induction furnace to produce high-purity Be.

AD-238449
Laboratories for Research and Development, Franklin Inst., Philadelphia, Pa.
DEVELOP HIGH PURITY BERYLLIUM AND DETERMINE THE MECHANICAL PROPERTIES OF MATERIAL PRODUCED. Edward Hein, Marvin Herman, and Grant E. Spangler, Bi-monthly progress rept. 1 Jan-29 Feb 60. 5p. incl. table (Rept. No. P-A2323-4) (Contract NOa(s) 59-6242-c)
An investigation was made to prepare high-purity Be and to study its deformation and fracture characteristics. A system of zone melting (floating zone in a totally enclosed recirculating inert gas loop) is being used to prepare samples from vacuum-cast Be prepared by the halide reduction process. The BeO content is about 0.2 wt-%. Circumferential rings of a precipitant were apparent in a solidified specimen after the initial pass, the number of rings increased downward along the bar. A portion of a Be rod which was zone melted twice was bent. The section deformed was a single crystal with the basal plane oriented 19° from the rod axis. Fracture occurred along the basal plane in a region where the bending stress of a cantilever beam is maximum. The strain in the outer fibers was estimated at 10 to 12%.

AD-238731
Alloyd Research Corp., Watertown, Mass.
RESEARCH ON TECHNIQUES FOR THE PRODUCTION OF ULTRA-PURE BERYLLIUM. Malcolm Basche and Laurence M. Schetky. Rept. for 1 July 58-30 June 59, on Metallic Materials. Mar. 60, 48p. (WADC TR 58-457, pt. 2) (Contract AF 33(616)5300)
Three techniques for making high purity Be were investigated: (1) zone purification in moderate vacuum, (2) distillation under high vacuum, and (3) purification through halide reduction of $BeCl_2$. Zone purification in vacuum proved to be impractical as a result of high Be vapor pressure. Distillation under high vacuum showed promise. Purification through halide reduction produced Be 99.6% and showed promise for improvement.

AD-239728

Laboratories for Research and Development, Franklin Inst., Philadelphia, Pa.

DEVELOP HIGH PURITY BERYLLIUM AND DETERMINE THE MECHANICAL PROPERTIES OF MATERIAL PRODUCED. Edward Hein, Marvin Herman, and Grant E. Spangler. Bi-monthly progress report. 1 Mar-30 Apr 60. 3p. (Rept. no. P-A2323-5) (Contract NOa(s) 59-6242-c)

Zone refining of Be was continued, and a electrochemical machining apparatus for producing tensile specimens from Be single crystals was designed and built. Four zone passes were completed on a 4-in. Be rod. Difficulty was encountered in the gettering procedure between the third and fourth passes. Upon heating the gettering bar, a white bubbly deposit appeared on the surface of the rod. It was concluded that the deposit was $BeSO_4$ which was retained (from the H_2SO_4 etchant solution) in tiny fissures present in the vacuum-cast ingot core material used for the gettering rod. The etching operation was performed after each pass to brighten the surface of the gettering bar to aid in detecting the completion of the gettering of the argon atmosphere. A piece of Pechiney Be was substituted as the gettering rod, and the fourth pass was completed successfully. During this pass it appeared that there was less oxide film on the surface of the bar than in previous runs; the amount of oxide increased toward the finishing end of the bar.

AD-242300

Laboratories for Research and Development, Franklin Inst., Philadelphia, Pa.

DEVELOP HIGH PURITY BERYLLIUM AND DETERMINE THE MECHANICAL PROPERTIES OF MATERIAL PRODUCED. Edward Hein, Marvin Herman, and Grant E. Spangler. Bi-monthly progress rept. 1 May-30 June 60. 6p. (Rept. no. P-A2323-6) (Contract NOa(s) 59-6242-c)

A single crystal Be tensile specimen was pulled to fracture at room temperature by the use of a standard Instron tensile machine. A strain rate of 7×10^{-5}/sec was used for the first 4% elongation, followed by a strain rate of 7×10^{-4}/sec from this point to fracture. The load at yielding was 55 lb, at fracture, 168 lb. The dominant slip was a basal glide as evidenced from slip line markings and the geometric relationship between the crystal orientation and the orientation of the elliptical cross section that formed during plastic flow. The final fracture was on the (1120) plane whose normal stress was a maximum i.e. the plane closest to 90° from the tension axis. The crystal yielded at a resolved shear stress of 1110 psi on the basal plane ($\theta = 70°$, $\lambda = 25°$). This zone-refined crystal exhibited greater ductility, associated with basal slip, than other Be crystals reported in the literature.

AERE-R-3321

United Kingdom Atomic Energy Authority, Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE PURIFICATION OF BERYLLIUM METAL BY A DISTILLATION PROCESS. E. W. Hooper and N. J. Keen. Nov. 1960 23p.

Commercial beryllium metal was purified in gram quantities by a distillation process involving condensation in a heated tube, the temperature of which was graduated from 1300°C at the bottom to 900°C at the top. The interim results show that many of the impurities that are volatilized with beryllium pass to the cooler end of the condenser and the purest metal was collected in a zone of 1100 to 1000°C. The anomalous behavior of certain impurities is described.

BM-RI-5581

Bureau of Mines
ELECTROREFINING BERYLLIUM. PRELIMINARY STUDIES. M. M. Wong, F. R. Cattoir, and D. H. Baker, Jr. June 1959 12p.

A brief investigation was made to determine the feasibility of electrorefining Be in a KCl-LiCl-$BeCl_2$ bath. Thin, platelike crystals of Be metal were produced by electrolyzing technical-grade Be metal beads (about 94% purity) as the soluble anode. Operating cell conditions were: Temperatures of 450 to 600°C.; an inert atmosphere; bath compositions of (1) 38.1 mole% KCl, 54.8 mole % LiCl, and 7.1 mole % $BeCl_2$ and (2) 36.7 mole % KCl, 52.7 mole % LiCl, and 10.6 mole % $BeCl_2$; cell voltages of 0.30 to 0.80; and initial cathode current densities of 50 to 435 amp/sq ft. Current efficiencies ranging from 87 to 96% were obtained. Qualitative spectrographic analyses of the metal products indicated that impurities were reduced. This technique offers the possibility of producing a grade of Be purer than that now generally available, which may have better mechanical properties.

BM-RI-5941

U. S. Bureau of Mines, Report of Investigations
SOLVENT EXTRACTION OF BERYLLIUM FROM SULFATE SOLUTIONS BY ALKYLPHOSPHORIC ACID. R. O. Dannenberg, D. W. Bridges and J. B. Rosenbaum. 1962, 6p

Organophosphate solvent extraction of Be from leach solutions of subgrade Be bearing materials prepared by H_2SO_4 leaching of lime-sintered low-tenor beryl flotation concentrates.

BM-RI-5959

U. S. Bureau of Mines, Report of Investigations
ELECTROREFINING BERYLLIUM. M. M. Wong, R. E. Campbell and D. H. Baker, Jr. 1962, 14p

Be is electrodeposited from a LiCl-KCl eutectic with varying amounts of $BeCl_2$. Determination of the effect of electrolyte composition, temperature and deposition rate on the quality, yield and purity of the Be crystalline product.

CEA-tr-X-256

PROCEDURE FOR OBTAINING DIRECTLY BERYLLIUM ALLOYS OF CONCENTRATION GREATER THAN 25% BERYLLIUM USING ANY MISCIBLE METAL, INCLUDING PURE BERYLLIUM. Translated by L. Roulet from Italian Industrial Patent 349, 185. Addition to Patent 342, 591. June 9, 1937 10p.

Direct production of Be alloys by a reaction of a Be compound or mineral with a scorifying metal or metalloid in alloy having a specific weight higher than the Be compound used. Just below the fusion temperature of the scorifant, the reaction mass is violently agitated either by mechanical means or by electromagnetic induction.

DMIC Memo 76
Defense Metals Information Center, Battelle Memorial Institute
PRODUCTION AND AVAILABILITY OF SOME HIGH-PURITY METALS
Dec. 1960 58p (Available as PB 161226 from U. S. Office of Technical Services, Washington 25, D.C.)

Electrolysis, leaching, vacuum distillation and reduction of Be, B, Cr, Cb, Fe, Mo, Ni, Re, Ta, Ti, W, V and Zr and the effect of the method of preparation on the purity of the product.

DMIC Memo 105
Defense Metals Information Center, Battelle Memorial Institute
REVIEW OF RECENT DEVELOPMENTS IN THE METALLURGY OF BERYLLIUM. Webster Hodge. May 10, 1961 5p (Available as PB171624, U. S. Office of Technical Services, Washington 25, D.C.)

LMSD-288233
Lockheed Aircraft Corp., Sunnyvale, Calif.
GRAIN REFINEMENT IN BERYLLIUM BY ALLOYING. D. Crooks and H. Sumsion SUMMARY rept. 1 July 58-31 Dec. 59. Jan. 60, 1v incl. illus. tables, (Contract NOrd-17017)

MAB-165-M (p. 439-56)
National Research Council. Materials Advisory Board
FLAT ROLLED PRODUCTS IN THE NEW NONFERROUS METALS AND ALLOYS (EXCEPT MOLYBDENUM, COLUMBIUM, TANTALUM, AND TUNGSTEN). William H. Santschi

The commercial purification process for Be is described. The fabrication and properties of sheet Be are discussed.

NMI-9502
Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT FOR THE PERIOD APRIL 1, 1960 TO JUNE 30, 1960. S. H. Gelles, July 26, 1960 25p (Contract AF33(616)-7065.

The objective of this program is to conduct a program aimed at making beryllium useful as a structural material. There are three major categories in this program: (1) purification, (2) joining, and (3) flow and fracture. The philosophy behind these programs is two-fold: first, to increase the usefulness of beryllium by advancing the technology of the material and by understanding the process and metallurgical factors involved in this technology; second, to improve present-day beryllium purification, working, heat treatment, and alloying. Within the three major categories are 12 projects, approximately 40% of which are to be carried out at NMI, the remaining 60% to be subcontracted. A list of these projects and the sites at which they will be carried out is given.

NMI-9509
Nuclear Metals, Inc., Concord, Mass
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT FOR THE PERIOD OCTOBER 1, 1960-DECEMBER

31, 1960. S. H. Gelles. Mar. 1, 1961 114p (Contract AF33(616)-7065

Work done on the development and research of beryllium is discussed. The areas include: purification by iodide decomposition, ultrasonic welding, distribution of oxides and voids, dislocation effects, surface damage, brazing, forge welding, resistance spot welding, distillation, product evaluation, aging and strain aging, and increasing the yield strength.

NP-8816

Reactive Metals, Inc., Niles, Ohio
THE ELECTRON BEAM MELTING OF BERYLLIUM, BORON, BORON CARBIDE, TANTALUM CARBIDE, TITANIUM CARBIDE, TUNGSTEN, AND ZIRCONIUM DIBORIDE. QUARTERLY PROGRESS REPORT NO. 8 FOR FEBRUARY 1-APRIL 30, 1960. R. L. Martin, S. R. Seagle, and O. Bertea. May 1960 21p (Contract AF33(616)-5603

Progress is reported in electron beam melting of beryllium, hafnium, vanadium, cobalt, molybdenum, and tungsten. Deoxidation of metals by additions of other metals and carbon during electron beam melting is also being investigated. Results indicate that hafnium can be purified by electron beam melting. Elements that are removed by double electron beam melting are Al, Co, Cr, Cu, Fe, Ge, In, Li, Mg, Mn, Mo, Ni, Si, Sn, W, O, N, and H.

NP-9819

Franklin Inst. Labs. for Research and Development, Philadelphia
PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. BI-MONTHLY PROGRESS REPORT, NOVEMBER 2, 1960 TO JANUARY 1, 1961. G. E. Spangler and M. Herman. 5p (Contract NOw61-0221-d)

Zone refining operations were started for Pechiney beryllium rods. A spark-discharge device was designed for machining tensile specimens from material being zone melted. A discussion is given of the potential for calcium as a deoxidizing agent for reducing BeO on the rod surface.

NP-9871

Franklin Inst. Labs. for Research and Development, Philadelphia
THE PREPARATION OF HIGH PURITY BERYLLIUM AND THE STUDY OF ITS FLOW AND FRACTURE PROPERTIES. FINAL REPORT, JUNE 30, 1959 TO JUNE 30, 1960. Marvin Herman, G. E. Spangler, and Edward Hein. (Contract NOas59-6242-c) 26p (F-A2323)

NP-9986

Franklin Inst. Labs. for Research and Development, Philadelphia
PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. BI-MONTHLY PROGRESS REPORT, JANUARY 2-MARCH 1, 1961. G. E. Spangler and M. Herman (Contract NOw-61-0221-d) 8p

Two single crystals of beryllium with the basal plane tilted ~ 20 and 45°, respectively, were subjected to eight zone refining passes which resulted in sufficient curvature to make further melting difficult. A specimen of the 20° crystal underwent, without fracture, a 180° bend about a radius approx equal to its diameter, 0.112 in. A specimen of the 45° crystal was tested to fracture in tension, and exhibited a 156% glide strain on the basal plane, equivalent to 92% elongation. Comparison of the critical resolved shear stress for basal slip of the 45°

crystal, 520 psi, with previously reported values suggests that the observed increase in ductility is the result of a decrease in the impurity concentration. The orientation of a third crystal, tested in tension, was such as to produce the duplex slip on $(10\bar{1}0)$ planes. The resolved shear stress on the basal plane at yielding was ~2000 psi. A 40% over-all elongation was produced with rather severe localized necking to almost a knife-edge fracture.

NP-10859

Franklin Inst. Labs. for Research and Development, Philadelphia PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. BI-MONTHLY PROGRESS REPT., JULY 2-SEPT. 1, 1961. G. E. Spangler, E. J. Arndt and M. Herman. (Contract NOw61-0221-d) 12p

Zone refining of 1 in. diameter extruded Be rods and vacuum cast and distilled bars. Specimen preparation from zone purified Be in tension. Observation of the change in the ratio of stress for basal slip to prism slip. Crystal failure at 32% elongation by basal plane cleavage. Several single crystals of zone refined Be are hot rolled and subsequently recrystallized to obtain highly oriented structures.

Patent - British 842, 226

IMPROVEMENTS IN OR RELATING TO METHODS OF PRODUCING MALLEABLE BODIES OF METALLIC BERYLLIUM. Harry William Dodds. (Brush Beryllium Co.) July 20, 1960.

A method for producing bodies of metallic beryllium is reported. The method consists of charging powdered Be into a mold and subjecting the interior of the mold and the beryllium to a preliminary heat treatment and evacuation at a temperature below sintering temperature until absorbed gas and vapor have been removed. Then combined evacuation, heat treatment, and mechanical pressure are applied to the beryllium at temperatures ranging from that at which sintering begins upward to that which produces pronounced grain growth.

Patent - British 871, 715

ARC FURNACE FOR MELTING REACTIVE REFRACTORY METALS. Richard John Fletcher. June 28, 1961

Patent - British 875, 539

PRODUCTION OF IMPROVED BERYLLIUM.
Thomas Raine and James Alan Robinson (Associated Electrical Industries Ltd.) Aug. 23, 1961.

Be of improved corrosion resistance to CO_2 at high temperatures is produced by melting under the action of an electric arc in vacuum or an inert gas of low pressure.

Patent - French 1, 206, 681

PROCESS FOR THE MANUFACTURE OF METAL INGOTS.
(Sylvania-Corning Nuclear Corp.) Aug. 31, 1959.

An improved process is described for the manufacture of ingots of U, Th, Pa, Zr, Be, or their hydrides. The metals in powder form are brought into a tube-shaped mould, then put under pressure between 4350 and 14500 kg/cm^2 at temperatures between 450 and 660°C. The resulting ingots or billets have nearly the density predicted by theory. If a nuclear fuel element with a container is wanted, a closely fitting tube of Al, Be, or Zr is inserted in the mould. The metal powder is

then introduced and sealed at both ends by discs of the same metal as the container, and the material is pressed at the correct temperature. A wholly and tightly contained fuel element results.

Patent - U.S. 2, 982, 644

PROCESS FOR THE MANUFACTURE OF BERYLLIUM. Jonas Kamlet. May 2, 1961.

BeF_2 is reacted with Mg in a reaction vessel at 650-1000°C. Molten NaF is added to the reaction product containing MgF_2 and Be to form a slag. Temperature of the mixture is maintained above the melting point of the slag containing NaF and MgF_2, but below the melting point of Be, thus effecting the separation of Be.

Patent - U.S. 2, 987, 454

ELECTROLYTIC PROCESS FOR PRODUCING METALS. B. Kopelman and R. B. Holden. (U.S. Atomic Energy Commission) June 6, 1961.

Reduction of beryllium halides to Be using a eutectic mixture with a melting point below the boiling point of Hg which acts as the cathode for the system.

Patents - U.S. 3, 049, 421

PRODUCTION OF METALS. Lloyd R. Allen. Aug. 14, 1962.

Metals including Al, Mn, Ag, Cr, Be, Cu, B, Si, Fe, Ni, Zn, Mg, Ti, Zr, Th and Bi are thermally evaporated from an induction heated crucible in a partial vacuum with an inert atmosphere and are condensed to fine, high-purity powders.

PB 171521

Lockheed Aircraft Corp. U.S. Office of Technical Services

VACUUM MELTING OF BERYLLIUM BY ELECTRON BOMBARDMENT. H. T. Sumison and C. O. Matthews. Dec. 1959, 43p

Smooth, homogeneous ingots 3 in. in diameter and essentially free of casting defects can be produced by this process. Vaporization loss during melting is not prohibitive for successful production. Ingots produced show improved cast structures and better machinability than induction-melted, vacuum-cast material.

PG-Report-268

United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England

ANALYTICAL METHOD FOR THE DETERMINATION OF PHOSPHORUS IN BERYL ORE. 1961 6p.

Fusion of a weighed portion of the ore with NaOH; leaching of the cooled melt with water and neutralization of the solution. Addition of ammonium nitromolybdate reagent separation of the precipitated ammonium phosphomolybdate.

TID-10059

Ames Lab., Ames, Iowa

PROCEEDINGS OF THE SPRING METALLURGY CONFERENCE, HELD AT AMES, IOWA, MARCH 24-26, 1952. V. 2

Compilation of papers concerning the production of Be and Zr, the physical properties and alloys of U, fuel element fabrication, metallurgy of Th and Zr, structures of metals and general physical metallurgy.

WADC-TR-58-457 (Pt. II)

Alloyd Corp., Cambridge, Mass.
RESEARCH ON TECHNIQUES FOR THE PRODUCTION OF ULTRA-PURE BERYLLIUM. JULY 1, 1958 TO JUNE 30, 1959. Malcolm Basche and Lawrence M. Schetky. Dec. 23, 1959. 54p (Project No. 7351) (Contract AF33(616)-5300).

Techniques for making high-purity Be such as zone purification in moderate vacuum, distillation under high vacuum, and purification through halide reduction of $BeCl_2$ were investigated. Zone purification in vacuum proved to be impractical as a result of high Be vapor pressure. Distillation under high vacuum showed promise. Purification through halide reduction produced Be 99.6% and showed promise for improvement.

WADC-TR-59-500

Illinois Inst. of Tech., Chicago. Armour Research Foundation.
BERYLLIUM RESEARCH FOR DEVELOPMENT IN THE AREA OF CASTING. PERIOD FROM JUNE 15, 1958 TO OCTOBER 14, 1959. Frank A. Crossley, Arthur G. Metcalfe, and William H. Graft. July 31, 1959 102p (Project Nos. 7021 and 7351) (Contract AF33(616)-5911)

SECTION V. BERYLLIUM METALLURGY

PART D. FOUNDRY

Carpenter, S. R.
HORIZON REQUIREMENTS FOR CASTINGS. Modern Castings, v. 40: 96-101 (September 1961)
Comparison of steel, Ti, Zr, Mo, Ta, Be and Cb castings to forgings in terms of costs and the designs required to restrict chronic defects in castings for aircraft applications.

Frity, J. C.
ADVANTAGES OBTAINED FROM THE USE OF CAST TOOLS. Machinery, v. 101, no. 2597: 430-434 (August 1962)
Precision casting using the Shaw process of carbon, alloy, tool and stainless steels, Al, beryllium copper, bronze, Co-base and Ni base alloy to produce dies and molds for various applications, with uniform physical and mechanical properties, dimensional tolerance, and surface finish.

Moore, W. F.
SPECIALTY MELTING AS A SERVICE FUNCTION IN A RESEARCH LABORATORY. Modern Castings, v. 40: 75-85 (October 1961)
Description of vacuum induction melting, consumable and inert electrode arc melting, atomic hydrogen melting and zone melting techniques and equipment applications to melting of various metals and oxides. Requirements for crucible materials.

Sharples, J. T.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 314-317 (October 1961)

Fonderia, v. 10: 341-345 (August 1961)
ALUMINUM CASTING FOR CHILLED AND DIE CASTINGS. (Italian)
Die and chill casting of Al, Al-Si and 356 Al alloy using three different furnaces for heating and rapid melting of the charge. Temperature control, Si modification by Na and grain refining of Ti, B, Zr, Be, Na and P.

Fonderia, v. 10: 360 (September 1961)
NEW LIGHT ALLOYS FOR DIE CASTINGS. (Italian)
Aging and die casting of 364 Al alloy. Alloy is corrosion resistant and offers good castability. Effect of temperature and of Cr, Be, Fe and Mg content on tensile strength, elongation and ductility. Linear-dimensional tolerances of castings.

Industrial Heating, v. 29: 48 (January 1962)
ELECTRO-HYDRAULICS TECHNIQUE USED TO FORM METAL.
Use of electric arc to rapidly heat H_2O to plasma producing a shock wave which uniformly stretches the workpiece to conform to the die. Forming of Ti, Cb, W, Be and stainless steel alloys into nuclear, missile and aircraft components.

Iron Age, v. 186: 50-51 (December 1960)
HOLLOW SPRUE: RADICAL DESIGN PROVES OUT IN PRODUCTION.
Precision investment castings composed of 4140 steel, Be, Al alloys and 17.4 Ph alloy produced using a hollow ceramic sprue to reduce segregation and decarburization. Metal is poured into the sprue while the ceramic-shell mold is under the influence of a vacuum assist.

Iron Age, v. 187: 98-99 (February 1961)
ELECTROSPARK FORMING: NEW WAY TO SHAPE HARD-TO-FORM METALS.
Shaping of Ti, W and stainless steel by capacitor discharge electrospark forming, a new process in which controlled explosions create shock waves of high force which blow intricate contours into the metals in millionths of a second.

Precision Metal Molding, v. 19: 43-54 (October 1961)
METAL CHOICE.
Castings and extrusion of bronze, nickel-brass, Al, Cu, Zn, beryllium copper, Mg, stainless steel, Ti and cobalt-brass alloys for applications utilizing the mechanical and physical properties of the materials.

Precision Metal Molding, v. 19: 60-67 (October 1961)
THE PHYSICAL AND MECHANICAL PROPERTIES OF METALS AND ALLOYS.

Precision Metal Molding, v. 19: 69-71 (June 1961)
CRITERIA FOR USING INVESTMENT CASTINGS.
Investment casting of a variety of shapes from Al, Co, Cu, Be, Cu, or Mg alloys, carbon steels, stainless steels and other alloys. Design criteria are given for size, dimensional tolerances and surface finish of the castings.

AD-209135
Beryllium Corp., Reading, Pa.
BERYLLIUM CASTING, PHASE I: (SEPTEMBER 19, 1958-NOVEMBER 19, 1958). Paul M. Cohen. (Contract AF 33(600)-37902)

AD-236656
Armour Research Foundation, Chicago, Ill.
BERYLLIUM RESEARCH FOR DEVELOPMENT IN THE AREA OF CASTING. FINAL REPORT FOR JUNE 15, 1958-OCTOBER 14, 1959 ON METALLIC MATERIALS. Frank A. Crossley, Arthur G. Metcalfe, and William H. Graft. February 1960. 92p. (WADC TR 59-500) (Contract AF 33(616)5911)
An investigation was made of Be casting to develop sound, fine-grained cast material. Areas investigated were: (1) X-ray determination of the direction of columnar growth in cast Be; (2) consumable arc casting of Be; (3) reported allotropy of Be by thermal analysis; (4) determination of grain-refining inoculants; and (5) application of vibration to cast Be for grain refinement. Evidence in support of the reported allotropy of Be was obtained. The pertinent findings were the following: (1) occurrence of a very pronounced thermal arrest 5 to 10°C below the solidification temperature of Be; (2) metallographic observations of transformation markings; and (3) lack of a preferred orientation for

columnar grains in cast Be. Vibration of cast, induction-melted Be showed promise. One ingot cast under vibration at 5 g acceleration and 60 cps showed substantial zones of relatively fine, equiaxed crystals. Representative grain size measurements gave 616 grains/sq. in. for this ingot compared to 316 grains/sq. in. for a static (standard) casting. Interrupted rotation was very effective in grain refining Al and is considered promising for Be. A rust-colored Ta nitride (identity uncertain), WC, and possibly TiB_2 apparently nucleated Be solidification to produce grain refinement. Also, an alloying addition of 1 at -% Ge produced grain refinement.

AD-254258

Ladish Co., Cudahy, Wis.
BERYLLIUM FORGING PROGRAM, PHASE III. INTERIM ENGINEERING REPORT NO. 4. MARCH 1, 1960-DECEMBER 31, 1960.
A. F. Hayes.

The importance of die design and sequence of forging operations, means of minimizing and localizing tensile stresses.

AD-266741

Beryllium Corp., Reading, Pa.
BERYLLIUM CASTING. INTERIM TECHNICAL ENGINEERING REPORT NO. 10, JULY 5-NOVEMBER 4, 1961 ON PHASE III. B. H. Hessler and J. P. Denny. November 1961, 22 p. (Contract AF 33(600) 37902; ASD Proj. 7-643)

Development of methods for the production of sound 3 in. diameter vacuum cast Be billets and flat slabs using a casting technique which relies on a thermal gradient within the mold to control the directional solidification of the metal and eliminate centerline shrinkage. Determination of cracking in the ingots by radiographic tests and sectioning.

KAPL-1917

Knolls Atomic Power Lab., Schenectady, N. Y.
GRAIN REFINEMENT OF CAST BERYLLIUM. A. E. Bibb and S. M. Bishop. April 1958. 19 p. (Contract W-31-109-Eng-52)

LMSD-288233

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif.
GRAIN REFINEMENT IN BERYLLIUM BY ALLOYING. TECHNICAL NOTE FOR JULY 1, 1958-DECEMBER 31, 1959. D. Crooks and H. Sumsion. January 1960. 42 p. (Contract NOrd-17017)

This paper was originally printed under the same title in Vol. II, "Metallurgy and Chemistry," of General Research in Materials and Propulsion, January 1959-January 1960. LMSD-288140.

Previously published data on the effect of alloying upon grain refinement of cast beryllium is reviewed. Experimental procedure is described for producing beryllium alloy buttons in a vacuum-inert atmosphere arc furnace with non-consumable electrodes and water-cooled copper hearth. A method for evaluating grain refinement of the alloy buttons is described. Results of the evaluations are given.

LMSD-480485

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif. VACUUM MELTING OF BERYLLIUM BY ELECTRON BOMBARDMENT. H. T. Sumsion and C. O. Matthews. December 1959. 41p. (Contract NOrd-17017)

A process is described for melting and casting beryllium ingots by electron bombardment, in order to produce a beryllium or beryllium-alloy ingot for fabrication into plate. Results are furnished of visual inspections, metallographic examinations, chemical and x-ray-diffraction analyses, and machinability, hardness, tensile strength, and bend tests. The effects of variables in both the melt stock and the processes are reported. It is concluded that smooth, homogeneous ingots three inches in diameter and essentially free of casting defects can be produced by the process described. Vaporization loss during melting is not prohibitive for successful production. Ingots produced show improved cast structure and better machinability than induction-melted, vacuum-cast material. Oxide content is reduced but no significant increase in ultimate tensile strength, or decrease in metallic impurities, was obtained. A method of analysis by gamma activation was developed and proved effective for determinations of exygen and carbon.

NP-8447

Mallory-Sharon Metals Corp., Niles, Ohio
THE ELECTRON BEAM MELTING OF BERYLLIUM, BORON, BORON CARBIDE, TANTALUM CARBIDE, TITANIUM CARBIDE, TUNGSTEN, AND ZIRCONIUM DIBORIDE. QUARTERLY PROGRESS REPORT NO. 7 FOR NOVEMBER 1, 1959-JANUARY 31, 1960. S. R. Seagle and O. Bertea. February 1960. 17 p. (Contract AF 33(616)-5603)

No further activity is reported in phase I; for information concerning activities in this phase see Quarterly Reports I through V. In phase II, beryllium extrusions were tested at elevated temperatures to determine the melting ratio and ductility. In phase III, a tungsten ingot hardness of 275 BHN is reported for a sample prepared by triple electron beam melting. Machinable hafnium ingots were produced by double electron beam melting; however, ingots produced by arc melting from sponge were brittle and could not be machined. Data on physical properties and chemical analyses of hafnium ingots are included. Data are also included on electron beam and arc melted vanadium ingots. In phase IV, procurement activities concerning elements for use in this phase are reported. (For preceding period see NP-8279) (J.R.D.)

NP-8797

Beryllium Corp., Reading, Penna.
BERYLLIUM CASTING — PHASE II. INTERIM TECHNICAL REPORT NO. 6 FOR DECEMBER 19, 1959-MARCH 18, 1960. Paul M. Cohen and R. C. Harris. 29 p. (Contract AF 33(600)-37902)

An evaluation was completed on the effect of pouring temperature and mold temperature on Be grain size. The results show a typical relationship of mold temperature and grain size with higher mold temperatures producing larger columnar grain diameters. Higher pouring temperatures produced smaller as-cast columnar grain diameters. No explanation is offered for this result. Small additions of Ge, La, and Zr were utilized as potential grain refining additions. Some columnar grain size reduction was accomplished but optimum amounts were not determined. (For preceding period see NP-8552)

NP-8911

Beryllium Corp., Reading, Penna.
BERYLLIUM CASTING. PHASE II. INTERIM TECHNICAL REPORT NO. 7 FOR MARCH 18, 1960-JUNE 17, 1960. Paul M. Cohen and R. C. Harris. 29 p. ASC Project 7-643. (Contract AF 33(600)-37902)

Additions of TaN (5 to 10%) did not produce any grain refinement in cast Be, No W was detected in melts to which WC was added. Some improvement in casting soundness resulted from the use of Ag as an alloying condition; grain refinement did not occur. Step castings, using rapid cooling methods, were cold rolled and recrystallized to a fine, equiaxed grain size. (For preceding period see NP-8797) (C. J. G.)

NP-9477

Beryllium Corp., Reading, Penna.
BERYLLIUM CASTING. INTERIM TECHNICAL REPORT NO. 8, PHASE II FOR JUNE 18, 1960-SEPTEMBER 17, 1960. Kenneth C. Taber and R. C. Harris. 37 p. ASC Project No. 7-643. (Contract AF 33(600) -37902)

An evaluation of alloy additions of lanthanum and zirconium is described. Increasing columnar grain refinement results with increasing alloy additions of lanthanum. Zirconium as an alloying grain refiner has an optimum concentration of 0.40 to 0.60 wt. % for maximum columnar grain refinement. The step castings show the reduction of columnar grain size by increasing the cooling rate. Heat treating with prior cold reduction to promote recrystallization of the cast structure has yielded tentative relation for recrystallization time and temperature for 10% cold bare rolled cast beryllium. A trend has been observed with an optimum per cent cold reduction for a given heat treatment for maximum grain refinement. These tentative results require more work to definitely establish certain points.

NP-9958

Beryllium Corp., Reading, Penna.
BERYLLIUM CASTING, PHASE II. FINAL REPORT, SEPTEMBER 19, 1958-DECEMBER 15, 1960. Kenneth C. Taber and R. C. Harris 60 p. (Contract AF 33(600)-37902)

A reliable technique for producing fine-grained, sound beryllium cast ingots was developed. Four approaches to obtain grain refinement were evaluated including; alloying additions, inoculation, mold vibration, and accelerated cooling through mold design. Of these, the latter was the most effective in achieving sound, fine-grained ingots. The alloying additions in varying amounts of lanthanum, zirconium, germanium, and silver were evaluated for grain refinement effects. Five ingots were poured with lanthanum additions of 0.07% to 0.5%. Ingot XP-183 with 0.07% lanthanum produced the lowest average grain size of 0.115 (mm) in this series. Thirteen ingots containing zirconium additions from 0.15% to 2.43% were evaluated. Ingot XP-186 in this group with 0.27% zirconium had a low average grain size of 0.097 (mm). Eleven germanium alloy castings were poured with germanium concentrations of less than 15 ppm to 0.69%. In this series ingot XP-96, having 0.13% germanium, had the lowest average grain size of 0.101 (mm). The silver alloy series included six castings. The amount of silver additions varied from 0.23% to 16.1% with ingot XP-89 (4.94% silver) having the lowest average grain size of 0.137 (mm). The zirconium alloy containing 0.27% zirconium, poured at 1350° C into a cold 1.5-in.

diameter mold produced the lowest average grain size. Other alloying elements including aluminum, titanium, silicon, and silver were used either singly or in combination to evaluate their effect on surface finish, apparent fluidity of the melt, and ingot soundness. Fifteen heats were poured. The silicon and titanium in combination produced good fluidity and sound castings were produced using a combination of titanium, silicon, and silver. Tantalum nitride and tungsten carbide were found to be ineffective as inoculants, in the concentrations obtained in the eighteen melts poured. The use of a low frequency mechanical vibration of the mold produced grain refinement in six ingots poured. The study suggests that a higher energy in either frequency or amplitude would be beneficial in breaking up the columnar grains as they grow during solidification. The use of heavy-walled molds made of high thermal conductivity materials to control solidification rates was most effective in achieving sound, fine-grained ingots. Three fine-grained ingots were extruded at a reduction ratio of 4.5:1. The first ingot containing 0.76% silver was poured at 1300° C. The second contained 1.22% silver and was poured under the same conditions. The third ingot was unalloyed beryllium poured at 1400° C. No vibration was used on the molds of these ingots. Sections of the first two extrusions were clad and subsequently rolled to 0.090 sheet. Metallographic examination of the sheet indicated that a recrystallized structure can be produced which is equiaxed and has a grain size comparable to hot-pressed beryllium powder.

NP-11072

Beryllium Corp., Reading, Penna.
BERYLLIUM CASTING. INTERIM TECHNICAL ENGINEERING REPORT NO. 10, REPORTING PERIOD, JULY 5-NOVEMBER 4, 1961.
B. H. Hessler and J. P. Denny. 27 p. (Contract AF 33(600)-37902)

Production of sound vacuum cast Be billets suitable for fabrication. The casting technique relies on a thermal gradient within the mold to control directional solidification of the metal and to eliminate the centerline shrinkage. Radiographic tests and sectioning to determine the cracking present.

ORNL-2988 (p. 283-430)

Oak Ridge National Lab., Tenn.
METAL FORMING AND CASTING. R. J. Beaver, W. J. Kucera, et al.

Material development work during the past year can be categorized into three areas: (1) aluminum-base fuel elements for low- and medium-temperature reactor applications, (2) stainless-steel-base components for medium-temperature reactors, and (3) beryllium tubing and uranium monocarbide arc-melted shapes for high-temperature systems. In the low-temperature aluminum-base research reactor field, it was concluded that a dispersion of U_3O_8 in aluminum is an attractive fuel material in applications limiting the U^{235} enrichment to 20% after demonstrating that the conventional plate type fuel element can be fabricated relatively economically even though 1000 g of uranium is required per fuel element. This conclusion was based on data obtained from fabricating more than 70 experimental fuel elements for the pool type reactor at the Puerto Rico Nuclear Center. Studies on the irradiation behavior of both UO_2 and U_3O_8 as a dispersoid in aluminum with and without a boron additive, for high-specific-power applications in the low- and medium-temperature range, showed that both the fissile com-

pound and the boron can be incorporated in aluminum by powder-metallurgy processing with acceptable homogeneity. The alloy type X8001 is of interest for medium-temperature reactors. Current results reveal that although conventional tests of roll-bonded X8001 material indicate achievement of metallurgical bonding, blisters develop at the bonded interface at the periphery of roll-clad plates when the specimens are subjected to autoclave tests at 290°C. Considerable effort in the aluminum-base medium-temperature reactor field was directed toward development of a 600-plate fuel element for the High Flux Isotope Reactor, which is designed to operate at a heat flux of 1.5×10^6 $Btu \cdot hr^{-1} \cdot ft^{-2}$ and a neutron flux in the trap of 5×10^{15} $neutrons \cdot cm^{-2} \cdot sec^{-1}$. The reference fuel material is an aluminum-base alloy containing 30 wt. % U-2.0 wt. % Si-0.05 wt. % B. Preliminary results indicate that boron and uranium can be distributed uniformly in 30 wt. % U-2 wt. % Si-0.05 wt. % B-Al alloy, that the fuel material can be roll clad into composite plates, and that the plates can be marformed into an involute shape and mechanically joined between two concentric tubes into a fuel-element array. In the development of fuel, neutron absorbers, and burnable poison materials for medium-temperature water-cooled and -moderated reactors, studies on UO_2 swage clad with austenitic stainless steel showed that internal cracking of the stainless-steel cladding is a problem when working with temperatures above 600°C and reductions in area greater than 65%. Postirradiation results on full-size plate-type UO_2-stainless-steel fuel elements revealed no significant damage in material containing 26 wt. % UO_2 after a maximum burn-up of 32% at 260°C in the SM-1 reactor. Postirradiation examination of full-size 3 wt. % B-Fe neutron absorbers from this reactor showed evidence of significant damage to the material after 18 at. % burn-up of the B^{10}. However, calculations based on a boron gradient design indicated that it may be possible to increase the B^{10} burn-up to 25 at. % burn-up with no damage. Studies on the compatibility of boron and boron compounds in stainless steel revealed reactions between SrB_6 and YB_6 and the austenitic stainless steel. It was also demonstrated that 4 wt. % elemental boron was compatible in type 200 stainless steel powder metallurgy compacts but not with type 347 stainless steel. Additional work on dispersions of Eu_2O_3 indicated that characteristics of the basic oxide may be responsible for swelling during sintering of austenitic-stainless-steel compacts containing dispersions of this material. Additional work on the UO_2-type 430 stainless-steel irradiation program was limited to fuel element design. Development in the high-temperature sodium-cooled reactor field demonstrated that flat thickplate stainless-steel fuel elements, containing a dispersion of 33 wt. % spherical UO_2 can be fabricated and that uranium alloys containing 10 to 17 wt. % Mo can be vacuum-induction melted and extruded into rod with no difficulty. Gas-cooled development included procurement of beryllium tubing produced by various fabricators and the establishment of a subcontract with Nuclear Metals, Inc., to evaluate various extrusion parameters involved in the fabrication of beryllium tubing. Arc-melted uranium monocarbide shapes were also prepared in support of an irradiation-testing program of this highly regarded fuel compound.

Patent - U.S. 3,028,234

PROCESS FOR PRODUCING MIXTURE REFRACTORY METAL OXIDES AND METAL AND PRODUCT THEREOF. Sherwood F. West, Ralph K. Iler and Guy B. Alexander. April 3, 1962.

Small dispersed particles of a refractory metal oxide are incorporated into an inactive metal, then mixed with a melt containing an active metal and cast.

SECTION V. BERYLLIUM METALLURGY

PART E. PRIMARY MECHANICAL WORKING

Boxall, D.

THE B.N.F. ROLLER STRETCHER MACHINE AS AN AID TO HIGH-SPEED PRESS FEEDING. Sheet Metal Industries, v. 39: 41-48 (January 1962)

Machine designed by the British Nonferrous Metals Research Assoc. to prevent edge-bow (edgewise curvature) consists essentially of a number of small rolls arranged as in a roller leveler through which the strip is pulled under tension.

Boxall, D.

ROLLER STRETCHING MINIMIZES EDGE BOW. Metalworking Production, v. 105: 79-82 (December 6, 1961)

Use of a roller stretching process to eliminate edge bow or curvature that occurs when narrow brass, Al and Al alloy, steel or Be-Cu strip is slit from wider material. Design and operation of equipment. X-ray testing of steel strip to determine the effects of roller stretching on surface residual stress.

Brayman, Jacob

ASPECTS OF HEAVY PRESS UTILIZATION. Mechanical Engineering, v. 83: 50-51 (September 1961)

Die forging and deep drawing of Ti, Al, Be, V, Mo, W and stainless steel into panels used in space craft, missiles and tanks. Data are given for rigidity and tensile strength of the metals.

Brock, P., Bowers, J. E., and Smith, D. D.

A MACHINE FOR CORRECTING THE SHAPE OF STRIP. Institute of Metals, Journal, v. 90: 1-6 (September 1961)

Design and application of a stretching device which consists of a number of small rods, followed by a series of progressively larger straightening rolls, over which metal strip can be pulled under tension resulting in correction of bad strip shape and the inherent tendency to edgewise bow on subsequent slitting. Application in straightening and flattening bronze, brass, Be-Cu, Al and mild steel. Soft material is slightly hardened by treatment in the machine but the properties of half-hard, or harder, material are not significantly affected.

Denny, J. P. and McKeogh, J. D.

FORGING UNCLAD BERYLLIUM. Journal of Metals, v. 13: 432-433 (June 1961)

Be forgings with improved tensile and yield strengths over those of conventionally hot pressed products are produced by preheating to 1400°F., restricting the starting blank size using a special solid lubricant and maintaining a high (800-900°) die temperature.

Dieter, George E. Jr.

MECHANICAL METALLURGY. McGraw-Hill Book Co., 330 W. 42nd St., New York 36, New York, 1961, 615p.

Fellom, Roy
BERYLLIUM. Light Metal Age, v. 19: 9, 12, 23 (December 1961)
Reveiw of fabrication techniques and mechanical properties for beryllides made by reacting mixtures of blended Be and refractory metal powders including Ta, Cb and Zr at high temperatures. Application to inertial guidance systems, high strength-weight electrical wire and cladding for nuclear fuel elements.

Flemings, M. C., Niiyama, E., and Taylor, H. F.
FLUIDITY OF ALUMINUM ALLOYS. Modern Castings, v. 10: 75-85 (December 1961)
Effect of Ti, Fe, Mn, Co, Cr, Si, Mg, Ca and Cu additions on liquidus temperature, solidification range and nature of primary crystals formed during casting of Al-4.5% Cu alloy.

Hessinger, P. S. (National Beryllia Corp., Haskell, New Jersey).
BERYLLIA. ENGINEERED SPACE AGE MATERIAL. Ind. Eng. Chem., 54 No. 3: 16-21 (March 1962)
Preparation, isostatic and dry pressing and extrusion processes and safety precautions during fabrication of beryllia.

Hessler, B. H.
ROLLING OF BERYLLIUM SHEET TAKES SPECIAL TECHNIQUE. Iron Age, v. 186: 136-138 (December 1, 1960)
Be slabs are machined, inspected clad with mild steel and formed into sheet by a cross rolling method at 1400-1500°F.

Hessler, B. H.
FABRICATION OF BERYLLIUM SHEET. Light Metal Age, v. 19: 10-12 (February 1961)

Hessler, B H. and Denny, J. P.
FABRICATION OF BERYLLIUM SHEET FROM HOT PRESSED POWDER. Paper from "Progress in Powder Metallurgy". v. 17. Metal Powder Industries Federation, New York 17, 1961, p. 5-11.
Hot rolling at 1400-1800°F. of hot pressed and sintered Be slabs after machining and cladding with mild steel (the cladding being removed after rolling by hot shearing and stripping). Influence of microstructure, grain size, orientation, reduction ratio, rolling direction and recrystallization annealing at 1500°F. on yield and tensile strengths, ductility, elongation and crack susceptibility. 8 ref.

Hockett, John E.
RECENT RESEARCH IN METAL FORMING. Applied Mechanics Reviews, v. 15: 157-166 (March 1962)
Consideration of desirable mechanical properties of the materials and deformation mechanisms inherent in the deep drawing, stretch forming, rolling, extrusion and high-energy rate forming of Al, Ti, Ta, Cb, Zr, V, Be, high strength steels and refractory metals. 89 ref.

Knapp, A. A.
DESIGN CLUES FOR INVESTMENT CASTING. Design Engineering, v. 7: 51-53 (September 1961)
Summary of tolerances and shrinkage allowances for precision investment casting of tubes, shapes, bars and sections. Data are given

for flatness, straightness, concentricity, roundness, hole positioning and length for the metal castings, wax patterns and cores. Minimum wall thicknesses are suggested for bronzes, brasses and Cu-Be alloys.

Kobrin, C. L.
NEW TECHNIQUES IN METAL FORMING. Iron Age Metalworking International, v. 1: 13-15 (June 1962)
Effect of forging, extrusion, drawing, rolling, impacting and other metal forming techniques on mechanical properties of various refractory metals, steels and alloys.

Kunkler, William C. Jr. and Canal, Jose R.
FORGINGS FOR MISSILES AND SPACE VEHICLES. Mechanical Engineering, v. 83: 45-49 (September 1961)
Die forging, roll forming, extruding and machining of Be, Ti, Ni-base alloys, refractory metals and low-alloy steel. Tensile and stress-rupture properties are given for Be and Ni-base forgings.

Loewenstein, Paul
THE EXTRUSION OF BERYLLIUM. Current Engineering Practice, v. 4: 16-20 (February 1962)

Lowy, Mortimer J. and Jaffee, Robert I.
DEVELOPMENT OF LOW-COST, FORMABLE, ALL-METAL SANDWICH PANELS WITH CORRUGATED CORES. Aerospace Engineering, v. 20: 14-15, 28-30 (November 1961)

Magie, Peter M.
PROGRESS REPORT ON MOLYBDENUM DISULFIDE AS COPPER AND COPPER ALLOY DRAWING LUBRICANT. Wire and Wire Products, v. 36: 995-997, 1070-1072 (August 1961)
Process parameters during wire drawing of Cu, beryllium copper, cupronickel, brass and phosphor bronze providing data on MoS_2 additions, which affect surface finish of the product, die angle and die wear.

Matveev, Yu. M. and Osada, Ya. E.
PRODUCTION OF THIN-WALLED SEAMLESS TUBES IN THE UK. Stal: 345-353 (May 1961) (English)
The equipment and technology employed in the cold drawing, heat treatment, finishing, inspection and testing of seamless tubing of carbon, alloy or stainless steels and nonferrous metals and alloys. Special features of the production of Mo, Cb, Ti, Ta, V, Zr and Be tubes are described.

Mayer, L. W.
HEAVY PRESSES IN THE SPACE AGE. Mechanical Engineering, v. 83: 44-45 (September 1961)
Space craft components are forged and extruded on presses from Be, Ti alloys, Ni-base alloys, refractory metals, Mg, Al, low-alloy steel and stainless steel. Effect of chemical composition and forging pressure on ductility and forgeability.

Miller, Bernard S.
"EXOTICS" MOVE AHEAD. Metalworking, v. 17: 11-13, 28-29 (October 1961)

Pardoe, J. P.
EXTRUSION OF METALS FOR NUCLEAR REACTOR APPLICATIONS. Metal Industry, v. 100: 426-429 (June 1, 1962)
Review of variables and process parameters for the extrusion of alpha and gamma U, Zr, Zircaloy-2, Be, Cu, cupro-nickel and mild and stainless steels selected as nuclear canning materials because of their resistance to coolant attack, compatibility with the fuel, neutron absorption capacities and mechanical strength.

Toczko, George A. and Breeze, Ken
WORKING BERYLLIUM. American Machinist/Metalworking Manufacturing, v. 104: 115-126 (October 17, 1960)
Data for machining, forming and joining of Be. Mechanical and physical properties of vacuum hot pressed, hot forged, hot rolled, hot extruded and annealed Be.

Waterhouse, D. F.
PRECISION TUBES FOR NUCLEAR APPLICATIONS. Australasian Engineer, v. 52: 87-91 (April 1961)
Cold drawing, sintering, hot extrusion and impact extrusion to produce gilled tubes of mild steel, stainless steel, Ti, Zr, Ni, Ta, V, Mo, Be, Mg and Al. Ultrasonic testing and eddy current testing to detect variations in thickness and curvature.

Australasian Manufacturer, v. 45, January 7, 1961, p. 36.
LOW-COST REVERSING NARROW STRIP ROLLING MILL.
"Stainless steel, Ni, Zr, Pt, Be, Cu, etc. . . are reduced to thin gauges by a. . . high mill."

Iron Age, v. 189, February 22, 1962, p. 99.
EXTRUDE LONGER BERYLLIUM SHAPES.
Extrusion of 39-ft. Be channels at 1725°F. having a dimensional tolerance of ±0.003 in., using a series of steel and Cu-type metallic lubricants and specially designed dies. Post annealing to improve ultimate strength and elongation properties.

Iron Age Metalworking International, v. 1, February 1962, p. 32-34.
METALLURGISTS REPORT PROGRESS IN FORMING BERYLLIUM.
Formation of Be components by either pressing encapsulated powders or forging hot pressed metal. Review of canned powder, canned block, bare block, hot pressing and extrusion methods. Determination of average density, tensile and yield strengths, elongation and contraction. Uses for aerospace heat shields, gyroscope parts, moderators and reflectors.

Light Metal Age, v. 19, June 1961, p. 11.
FORGING OF UNCLAD BERYLLIUM.
Ultimate strength of 67,300 psi., yield strength of 49,000 psi. and elongation of 5.1% are achieved without excessive oxidation or rupture by hot pressing with blanks preheated to 1400°F.

Light Metal Age, v. 19, June 1961, p. 18.
FABRICATION OF BERYLLIUM AND TITANIUM FOR THE SPACE CAPSULE.
Forging and machining operations on Be used as a heat shield for exposed areas of capsule. Welding of Ti sandwich structures. Increase in structure stiffness achieved by "rigidizing" or beading. Pressure testing.

Light Metal Age, v. 20, February 1962, p. 8-9.
MAGNETIC FORMING AND PLASMA FORMING.
Operating characteristics of equipment used for the electrohydraulic forming of Ti, Cb, W, Be and stainless steel and for the magnetic pulse forming, swaging, expanding and shearing of steel and Al.

Light Metal Age, v. 20, February 1962, p. 12-13.
BERYLLIUM EXTRUSION ADVANCES.
Extrusion of U-shaped channels 0.6 in. thick and 39 ft. long at 1725°F. using special dies and steel and Cu lubricants. Consideration of the elongation, ultimate and yield strengths and ductility of the channels.

Machinery (London), v. 99, September 20, 1961, p. 687-694.
DEVELOPMENTS IN THE FORGING OF MATERIALS FOR SERVICE AT HIGH TEMPERATURE.
Components for missiles and space vehicles are forged at 1000-5000°F. from medium-high temperature alloys (Inco 901, A286, V57), Ni-base superalloys (Astroloy, Rene 41, Waspaloy) and refractory metals (Mo, Cb, Ta, W).

Machinery (London), v. 100, May 9, 1962, p. 1062.
ROLLING VERY THIN FOIL.
Rolling of very thin steel, heat resistant alloy, Be-Cu, Ta, Zr, Cu, Cu-Ni and Ni-Cr foil using a pyramidal system of back-up rolls. Application of the foils for various electrical circuits.

Materials in Design Engineering, v. 53, May 1961, p. 19, 203.
METAL HONEYCOMB COSTS CUT.
Fabrication of beryllium.

Materials in Design Engineering, v. 55, March 1962, p. 11.
LONGEST BERYLLIUM EXTRUSIONS.
Extrusions 39 ft. long and 0.06 in. thick are produced at 1725°F. using a steel and Cu jacket as a composite solid lubricant. Tensile and yield strength, elongation and tolerance.

Metal Industry, v. 100, February 9, 1962, p. 102-104.
FORMABLE SANDWICH PANELS.
Fabrication processes including rolling at 845-980°C., coring with paper, fiberglass reinforced plastic or metal, brazing, pressure welding, soaking and bonding of A55 Ti, 15-7 Mo stainless steel, Rene 41, Be, Mo, A110 AT Ti and 6Al-4V Ti and Alclad 2014 Al alloys. Applications as missile and aircraft components subjected to high temperature and compression and bending loads.

Metal Industry, v. 100, March 16, 1962, p. 212.
ROLLING ULTRA-THIN FOIL.
Steel, Cu and Cu alloy, Zr, Ta, Cu-Ni and Ni-Cr alloy strip is rolled to a thickness of 0.0001 in. using pyramidal systems of back-up rolls supporting the work rolls over their entire length.

Metal Treatment, v. 28, February 1961, p. 53-58.
CLOSE-TO-FORM AND CLOSE-TOLERANCE FORGINGS.
Forging techniques at temperatures up to 1140°C. for steels, Nimonic alloys, Ti, Al alloys, Hiduminium and Mg alloy.

Metalworking Production, v. 105, February 15, 1961 p. 66.
FORMING BERYLLIUM.
Rolling, forging, forming or extrusion of Be above 1400°F. using metal clad in a mild steel, covered with a protective coating or handled under an inert atmosphere.

Missiles and Rockets, v. 10, January 8, 1962, p. 24.
PROCESS EXTRUDES SMOOTH BERYLLIUM.

Modern Metals, v. 28, no. 7, August 1962, p. 68, 70, 72.
EXPERIMENTAL HYDROSTATIC EXTRUSIONS POINT TO NEW PRODUCTION TECHNIQUES.
Al, Cu, 1020 steel, Be and yttrium are extruded by a process that utilizes hydrostatic pressure in the extrusion container in place of the conventional extrusion ram. Description of die design, tooling, and lubrication agents.

Precision Metal Molding, v. 19, October 1961, p. 43-54.
METAL CHOICE.

Precision Metal Molding, v. 19, October 1961, p. 60-67.
THE PHYSICAL AND MECHANICAL PROPERTIES OF METALS AND ALLOYS.

Reactor Core Materials, v. 3, August 1960, p. 51-60.
SPECIAL FABRICATION TECHNIQUES.

Sheet Metal Industries, v. 39, May 1962, p. 316.
ROLLING ULTRA THIN FOIL.
Foil, 1/1000 in. thick, of steel, Be-Cu, Ta, Zr, Cu, Cu-Ni and Ni-Cr is rolled on a Sendzimir mill, consisting of pyramidal systems of back-up rolls supporting the work rolls, to eliminate distortion.

Steel, v. 149, September 11, 1961, p. 102-108.
FORGERS EXTEND THEIR TECHNOLOGY.
Recent developments in forging of Be, Cb, Ta, W, superalloys, die steels, Ni and Mo alloys and other materials. Design of forging presses and other equipment for achievement of close tolerances.

Steel, v. 149, December 25, 1961, p. 50-54.
NEW MATERIALS, TECHNIQUES INCREASE VERSATILITY OF CERAMICS.

Steel, v. 150, January 22, 1962, p. 67.
COEXTRUSION TRIPLES LENGTH OF BERYLLIUM CHANNELS.
Fabrication of 39-ft. U-channels at 1725°F. using metallic lubrication to prevent welding of the metal to the extrusion dies. Inspection for cracking, tearing and surface finish.

Steel & Coal, v. 184, April 27, 1962, p. 813.
ROLLING OF ULTRA THIN FOIL.
Use of pyramidal systems of back-up rolls to support work rolls prevents roll distortion. Applications of foil fabricated from steel, heat-resistant alloys, Be-Cu, Ta, Zr, Cu, Cu-Ni alloys and Ni-Cr alloys.

Western Machinery and Steel World, v. 53, January 1962, p. 40-42.
NEW DEVELOPMENTS IN EXTRUDING BERYLLIUM TO AID SPACE-AGE STRUCTURES.

Utilization of metallic lubricant composed of Cu and steel and die press that equalizes metal flow at 1725°F. to produce 24 in. extrusions with good ultimate tensile and yield strengths, elongation and thickness tolerances without cracking or rattlesnaking.

AD-243448

Brush Beryllium Co., Cleveland, Ohio.
FABRICATION OF BERYLLIUM FINE WIRE. A. G. Gross, R. G. O'Rourke, and W. W. Beaver. Progress Report No. 2, June 1, 1960 to August 1, 1960, 13p. Contract NOas 60-6108-C.

The wire-drawing apparatus described previously was completed and tested, and is being altered to include a variable-speed drive on the capstan. Facilities for cleaning the wire were installed. Since the surface conditions of the wire were found to become more important as the diameter decreased, an investigation was made of surface preparation techniques to find a commercially feasible solution which would effectively dissolve beryllium while improving the plastic flow properties of the surface. The solution containing 0.3 wt. % HF and 15.4 wt % HNO_3 in water was the preferred mix and performed better at 70°C than at room temperature. As-received sample diameters were measured at three different longitudinal positions. The measurements were repeated during pickling in the HF-HNO_3 solution at 70°C, and the times for various amounts of surface removal were recorded. It was concluded that this concentration, when used at 75 ± 5°C, produced a very uniform attack at a rate of ~0.005 in. of surface removal per minute. The treated wire was bend tested by making 180° free bends around mandrels of known diameter. Each specimen was wrapped on successively smaller mandrels until fracture occurred. The bend radii immediately preceding and at fracture were noted and were expressed as α, the ratio of the inside bend radius to the specimen diameter. The values of α are considered accurate to ±0.50. The test data are tabulated and given graphically as minimum bend radius as a function of stock removal. (B. O. G.)

AD-248985

Materials Advisory Board, National Research Council, Washington, D. C.
STATE-OF-THE-ART REPORT BY THE PANEL ON FORGING AND EXTRUSION OF THE COMMITTEE ON THE DEVELOPMENT OF MANUFACTURING PROCESSES FOR AIRCRAFT MATERIALS (AMC). October 15, 1960, lv. (Rept. no. MAB-139-M(F3))(Contract DA 36-039-sc-76436)

Methods were surveyed for forging and extruding aerospace metals. The principal materials, the atmospheres and heating temperatures, the several forming techniques, the maximum and minimum product dimensions, and tolerance approximations are discussed. The materials include the conventional soft metals such as Al, Mg, Cu, and brass, a great variety of high-strength and high-temperature steels, many super alloys containing over 50% alloying material, several reactive metals (Ti, Be, Zr and their alloys), and the refractory metals (W, Mo, Nb, and Ta). The major forming difficulties are associated with refractory metals and the toxicity and

atmospheric contamination of the reactive metals. Precision forging, with the exception of turbine and compressor blades, is not economically feasible. Precision extrusion of the softer metals below the recrystallization temperature is used to secure close tolerances and high mechanical properties.

AD-249081

Northrop Aircraft, Inc., Hawthorne, California.
PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. Interim engineering rept. no. 10, 1 September 30-November 60, 22p. incl. illus. (Rept. no. NOR-61-6) (Contract AF 33 (600)36931)

The major problems of beryllium extrusion are being investigated. The feasibility of unclad beryllium extrusions was adequately demonstrated in Phase I proper, but additional work was considered necessary to perfect extrusion methods to the degree where a full 20 feet of defect free section could be reliably and repetitively fabricated. Ten to twelve feet long lengths of defect free material were produced occasionally in the Phase I extension. The most recent efforts at Nuclear Metals were directed toward the development of the full 20 feet and the extrusion from Push No. 135 resulted in a 26-foot long extrusion with only a few defects. This represents the longest extrusion to date. It had not been possible to establish a reasonable degree of consistency and this lack of consistency was attributed to the rather low top speed of the Nuclear Metals press. Because of this, arrangements were made to have exploratory extruding efforts made at the facility of Wolverine Tube in Allen Park, Michigan. The results of this high ram speed test were quite favorable. Reproducible results were obtained with set conditions, and, when minor variations were programmed, differential results were observed. The consistent and very rapid speed of the ram minimized the variations of temperature which would otherwise have occurred on the much slower N. M. F. press. Three consecutive 11-foot long beryllium extrusions were made without the customary tearing defect.

AD-260001

Northrop Aircraft, Inc., Hawthorne, California
PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES.

Extrusion, fabrication and lubrication of billets of Be, steel and Cu which undergo streamline flow.

AD-260945

Ladish Co., Cudahy, Wisconsin.
BERYLLIUM FORGING PROGRAM. Interim engineering rept. no. 5, on Phase 3, January 1-March 31, 1961, A. F. Hayes. March 31, 1961, 32 p. (Contract AF 33 (600) 36795).

Production of unclad Be extrusion forgings using the expendable hot carbon steel support technique to minimize excessive tensile stresses.

AD-265840

Brush Beryllium Co., Cleveland, Ohio.
ROLLING IMPROVED BERYLLIUM SHEET. E. M. Grala, R. G. O'Rourke and others. Quarterly rept. no. 1, July 4-October 4, 1961. October 4, 1961. 24p. 11 refs. (Technical rept. no. 231-234). (Contract AF 33(600) 430 37).

Development of Be sheet with improved reproducibility and mechanical properties in a flat condition. Study of the isotropic ductility phase.

AD-265935

Northrop Corp., Hawthorne, California
PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. L. M. Christensen. Interim engineering rept. no. 13, June 31-August 31, 1961. August 1961, 63p. (Rept. no. NOR-61-236) (Contract AF 33 (600) 36931).

Pilot production of 20-ft. structural channels. Determination of dimensional integrity, surface quality, freedom from defects, strength and ductility.

AD-266876

Ladish Co., Cudahy, Wisconsin
BERYLLIUM FORGING PROGRAM. A. F. Hayes and J. A. Yoblin. Interim technical engineering rept. April 1-September 30, 1961. November 1961, 46p. (Contract AF 33 (600) 36795, Proj. 7-647) (ASD TR 7-647, Vol 6).

Forging of unclad Be in closed dies on an experimental production basis using expendable die components of hot carbon steel. Reduction of tensile stresses while deforming plastically. Tooling and forging sequences are developed. Properties of Be heated to 1525°F. for 16 hr. and air cooled.

ASME Paper 60-WA-316

FORGINGS FOR MISSILES AND SPACE VEHICLES. Jose R. Canal and William C. Kunkler, Jr. 1960, 15p.

Forging of steel, Ti, Be, Al, Ni and refractory metals for application in reentry and space vehicles, missile frames and guidance systems, solid propellant rocket motors, liquid propellant rocket engines and nuclear rocket motors. 13 ref.

ASME Paper 60-WA-317

ASPECTS OF HEAVY PRESS UTILIZATION. J. Brayman, 1960, 5p.

Closed-die forging and cylindrical billet extrusion of Al alloy, stainless steel, alloy steel, tool steel, Be, Mo and W to produce aircraft and missile components. Use of auxiliary tooling and mechanical handling and heating equipment.

DMIC Memo 105

Defense Metals Information Center, Battelle Memorial Institute.
REVIEW OF RECENT DEVELOPMENTS IN THE METALLURGY OF BERYLLIUM. Webster Hodge. May 10, 1961, 5p. (Available as PB171624, U. S. Office of Technical Services, Washington 25, D.C.)

GA-2262

Brush Beryllium Co., Cleveland, Ohio. For General Atomic Div., General Dynamics Corp., San Diego, California
MARITIME GAS-COOLED REACTOR PROGRAM. TECHNICAL FEASIBILITY STUDIES OF FABRICATION TECHNIQUES APPLICABLE TO THE MANUFACTURE OF HIGH-DENSITY BERYLLIA TUBES FOR POTENTIAL UTILIZATION IN THE MARITIME GAS-COOLED REACTOR. Chester A. Bielawski, Edward A. Douglas and John G. Theodore. Final Report, May 9 to June 30, 1960. Contract AT(04-3)-187, 50p. ISS 60085

MAB-165-M

National Research Council. Materials Advisory Board.
FLAT ROLLED PRODUCTS IN THE NEW NONFERROUS METALS AND ALLOYS (EXCEPT MOLYBDENUM, COLUMBIUM, TANTALUM, AND TUNGSTEN). William H. Santschi. (p. 439-56).

NMI-1219

Nuclear Metals, Inc., Concord, Massachusetts
BERYLLIUM-CLAD URANIUM ELEMENTS, FABRICATION DEVELOPMENT BY MULTI-TEMPERATURE EXTRUSION, AND DIMENSIONAL STABILITY ON THERMAL CYCLING. J. Greenspan, March 18, 1960, 41p. Contract AT(30-1)-1565.

Some development studies are described concerning the co-extrusion of beryllium with either uranium or uranium having small alloy additions. Some test data on the general integrity of extruded rods are reported.

NMI-1250

Nuclear Metals Inc., Concord, Massachusetts
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY: EXTRUSION BY HYDROSTATIC PRESSURE. R. N. Randall, D. M. Davies, J. M. Siergiej and P. Loewenstein. Final Report for the Period July 1, 1960 through June 30, 1961. July 13, 1961. Changed from OFFICIAL USE ONLY August 2, 1961. Contract AT(30-1)-1565, 34p.

Experimental extrusions are made from a container in which the Cu, Al, mild steel, Y and Be billets are surrounded by a fluid under hydrostatic pressure at room temperature and 900°F.

NMI-2088

Nuclear Metals, Inc., Concord, Massachusetts
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for August 1960. September 30, 1960, 27p. Contract AT(30-1)-1565.

Work was begun on plans for the construction of the necessary modifications to the 100-ton vertical extrusion press to allow the extrusion of beryllium from a container filled with molten lead at 900°F.

NMI-9605

Nuclear Metals, Inc., Concord, Massachusetts
SECOND QUARTERLY REPORT TO WRIGHT AIR DEVELOPMENT DIVISION DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F. M. Yans, A. K. Wolff, and A. R. Kaufmann.

May 16, 1960, 28p. Contract AF 33 (616)-6616.

A summary of data is presented from rolling experiments in which the effects of reduction ratio and annealing heat treatments on the structure and orientation of cold-worked beryllium sheet were studied. Texture analysis experiments are also described in which the original and modified Schulz methods of texture analysis are examined, and studies to determine the relative importance of variables in the rolling process as they affect the structure and orientation of Be sheet are reported. Preliminary conclusions are included. (For preceding period see NMI-9602,)

NMI-9608

Nuclear Metals, Inc., Concord, Massachusetts
DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F. M. Yans, A. K. Wolff, and A. R. Kaufmann. Third Quarterly Report to Wright Air Development Division. May 17, 1960, 17p. Contract AF 33 (616)-6616.

Developments in the areas of beryllium crystal rolling, effects of turbulent flow during deformation, and initial photographic experiments in which a hot-stage microscope was used to examine polycrystalline beryllium samples are reported. (For preceding period see NMI-9605.)

NOR-60-192

Norair. Div. of Northrop Corp., Hawthorne, California
PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. Interim Engineering Report No. 8 [for] March 1, 1960 through May 31, 1960, 19p. Contract AF 33 (600)-36931.

The feasibility of unclad Be extrusion was demonstrated by the production of various extruded shapes up to 26-ft long with few defects. However, additional work is needed to perfect extrusion methods since consistency is still poor.

NOR-60-272

Norair. Div. of Northrop Corp., Hawthorne, California
PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. Interim Engineering Report No. 9 [for] June 1, 1960 through August 31, 1960, 11p. Contract AF 33(600)-36931.

This report documents and summarizes a portion of the total effort of the Beryllium Extrusion Development Program, Phase I. The work reported herein is part of an extension to Phase I in which the major problems of beryllium extrusion are being thoroughly investigated. Northrop Corporation, Norair Division, the prime contractor, and Nuclear Metals, Inc., the subcontractor. are working in close association to achieve project objections. Feasibility of unclad beryllium extrusion was demonstrated in Phase I proper, but additional work was considered necessary to perfect extrusion methods. 20-ft lengths of extruded shapes are desired; 5- to 6-ft shapes were made in Phase I proper; 10- to 12-ft lengths of defect-free material have now been realized; and efforts are now being directed toward method development for the 20-ft-long Phase I channel-shaped extrusions. Extrusion # 135 resulted in a 26-ft-long extrusion with only a few defects and thus represents the best effort to date. It has not, however, been possible to establish a reasonable degree of consistency. Because of the rather low top speed of the press and the

marginal tonnage available at its top speed, efforts are being made to have an exploratory extruding effort performed under Nuclear Metals auspices at another facility.

NOR-61-6

Northrop Aircraft, Inc., Hawthorne, California
PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. Interim Engineering Report No. 10, September 1, 1960 through November 30, 1960. Contract AF 33 (600)-36931, 28p.

A summary of activities in Phase I of the beryllium extrusion program is presented. The feasibility of unclad beryllium extrusions was demonstrated; however, additional work was considered necessary to perfect extrusion methods to the degree where 20 ft of defect-free section could be fabricated. Recent efforts directed toward the development of a 20-ft extrusions resulted in a 26-ft-long extrusion with few defects. This represents the longest extrusion to date. It had not been possible to establish a reasonable degree of consistency, and this lack of consistency was attributed to the rather low top speed of the Nuclear Metals press. Because of this, arrangements were made to have an exploratory extruding effort performed through Nuclear Metals at another facility with a newer and more adequate press. The results of high ram speed tests were quite favorable. For the first time in the program reproducible results were obtained with set conditions. The consistent and very rapid speed of the ram minimized the variations of temperature which would otherwise have occurred. Three consecutive 11-ft-long beryllium extrusions were made without a tearing defect. The next item of effort will be to further refine the process and to establish means of increasing the quality product to a full desired 20 ft. (For preceding period see NOR-60-272.)

NOR-61-66

Norair. Div. of Northrop Corp., Hawthorne, California
DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. INTERIM ENGINEERING REPORT NO. 11, DEC. 1, 1960-FEB. 28, 1961.

The effect of the press speed on the consistency of unclad Be extrusions.

NOR-61-163

Northrop Corp., Hawthorne, California
PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. INTERIM ENGINEERING REPORT NO. 12, MAR 1, 1961 THROUGH MAY 31, 1961.

Lubricant composition and extrusion speed are considered as factors affecting consistent production of defect-free Be lengths.

NP-9911

Beryllium Corp , Reading, Pennyslvania
DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. K. C. Taber and E. E. Weismantel. Second Interim Technical Report [for] Period October 29, 1960-January 28, 1961. Contract AF 33 (600)-41959, 44p.

The technical effort expended in the first three months after starting Phase II is described. The initial effort included the formulation of a detailed technical program with the prime objective of producing beryllium sheet and strip having properties of 55,000 and

75,000 psi in yield strength and ultimate strength, respectively. Various starting materials and rolling and extrusion parameters were evaluated for ultimate application in subsequent forming of structural angles, channels, and zees through bending processes. Studies of the other structural shapes, including tees, rounds, and squares, indicated that gross deformation processes are necessary to obtain the required properties. Square extrusions and hot-pressed stock were prepared for deformation experiments.

NP-10346

Beryllium Corp., Reading, Pennsylvania
DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. K. C. Taber and E. E. Weismantel.

NP-11238

Brush Beryllium Co., Cleveland, Ohio
FABRICATION OF BERYLLIUM FINE WIRE. A. G. Gross, Jr., R. G. O'Rourke and W. W. Beaver. Final Report. Technical Report 200-228, April 1961. (Contract NOas-60-6108-C) 62p.

Evaluation of lubricants and heat treatment procedures for the production of wires as thin as 0.00477 in. in diameter. Tensile and bend tests are conducted on the wire samples produced.

Patent - British 837,853

IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Jack Williams and William Munro (to United Kingdom Atomic Energy Authority). June 15, 1960.

A method is reported for the production of Be-clad U fuel elements.

Patent - British 884,108

IMPROVEMENTS IN OR RELATING TO THE FABRICATION OF BERYLLIUM. William Munro and Nigel Austin Hill. (United Kingdom Atomic Energy Authority). December 6, 1961.

Production of Be tubing with improved ductility at right angles to the extrusion direction, by boring a central hole in an extruded Be rod to form a billet and then extruding the billet to give a reduction in cross sectional area of not more than 15 to 1.

Patent - British 884,410

MANUFACTURE OF BERYLLIUM TUBES. Joseph Clifford Guest and William Arthur Sallis (to T. I. Group Services Ltd.). December 13, 1961.

Extrusion method for tubemaking using extensible metal cores and envelopes. The core-billet-envelope assembly is preheated to 900-1100°C.

SCR-306

Stevens Inst. of Tech., Hoboken, N. J. Powder Metallurgy Lab.
DEVELOPMENT OF MILITARY COMPONENTS FROM BERYLLIUM BY SLIP CASTING AND POWDER METALLURGY TECHNIQUES. Final Report, September 1959-September 1960. December 1961. For Sandia Corp., Albuquerque, New Mexico. (Contract AT (29-1)-789). 74p.

WADD-TR-60-32
Nuclear Metals, Inc. Concord, Massachusetts
BERYLLIUM RESEARCH AND DEVELOPMENT IN THE AREA OF COMPOSITE MATERIALS. Jacob Greenspan, Gerald A. Henrikson, and Albert R. Kaufmann. Rept. for 15 June 1958-14 June 1959 on Metallic Materials. July 60, 108p. incl. illus. tables, 31 refs. (Contract AF 33 (616) 5912, Proj. 7351)

SECTION V. BERYLLIUM METALLURGY
PART F. SECONDARY MECHANICAL WORKING
(FORMING AND MACHINING)

Bennett, K. W.
ELECTRIC MACHINING BUILDERS SIGHT MARKET BREAKTHROUGH. Iron Age, v. 188: 72-73 (September 1961)
Production of tungsten rocket nozzles, Be and other metal parts by electrical discharge and electrolytic machining. Advantages and limitations of the processes. Production and consumption statistics.

Bennett, W. D.
RESEARCH IN BERYLLIUM. Canadian Metalworking, v. 24: 29-31 (July 1961)

Blair, R. W., D. L. Johnson, and J. P. Morley
METAL BELLOWS SEALS. Lubrication Engineering, v. 17: 470-475 (October 1961)

Boulger, Francis
REVIEW OF SEVERAL RECENT METHODS OF MACHINING. Machine Moderne, v. 56: 89-93 (May 1962) (French)
Electric discharge, electrolytic, ultrasonic and electron bombardment machining, electrolytic grinding, chemical milling and plasma arc cutting at 5000-5500°C of steel, Fe alloys, various nonferrous metals and alloys and various nonmetallic materials to improve dimensional tolerance and surface finish. Determination of efficiency of stainless steel and brass machining tools and of electrodes.

Brayman, Jacob
ASPECTS OF HEAVY PRESS UTILIZATION. Mechanical Engineering, v. 83: 50-51 (September 1961)

Brown, George C. and James N. Behm
ULTRASONICS FOR METAL CUTTING. Tool and Manufacturing Engineer, v. 46: 57-60 (March 1961)
Applications of ultrasonic energy to conventional turning, milling and grinding operations.

Collins, Laurence W., Jr.
MACHINING THE ASTRO-METAL-PURE BERYLLIUM. Machinery, v. 67: 93-97 (June 1961)
Machining techniques for Be, taking into account the need for salvaging chips and preventing oxidation. Mechanical properties of Be. Physical properties as compared with those of other common structural metals.

Dieter, George E., Jr.
MECHANICAL METALLURGY. McGraw-Hill Book Co., New York, 1961, 615p.

Evans, W.
THE METALLOGRAPHY OF REACTIVE MATERIALS. Canadian Mining and Metallurgical Bulletin, v. 53: 893-900 (November 1960)
Methods for cutting, grinding and polishing U, UO_2, Zr, Zr alloys and Be for metallographic study.

Fellom, Roy
BERYLLIUM. Light Metal Age, v. 19: 9, 12, 23 (December 1961)

Fuchs, H. O.
SHOT-PEENING OFFERS NEW LIFE TO CRITICAL METAL PARTS. Iron Age, v. 188: 67-70 (August 1961)
Fatigue strength of steel shaft, springs and gears, Be-Cu springs and Al alloy inducers as affected by shot peening.

Gorcey, R. , J. Glyman, and E. Green
EXPLOSIVE FORMING. Machine Design, v. 33: 188-190 (April 1961)
Design considerations for high energy fabrication of hard-to-form materials and shapes. Application of explosive forming to 2024 and 6061 Al alloys, AZ31B Mg alloy, 4130 and 4340 steels; Vascojet 1000; 17-4PH, 17-7PH, 15-7MO, AM355 and 20CB stainless; Rene 41, Hastalloy X, Inconel X, HS21 Co alloy, 6Al-4V and B120VCA Ti alloys; Mo alloys and Teflon and Kel-Fusing plastic using deflagration or detonating explosives.

Grimm, Karl and Rodney Schultz
HYDRAULICS AID PRECISION HOLDING. American Machinist/Metalworking Manufacturing, v. 105: 76-77 (March 1961)
Finish turning of small tubular beryllium copper cylinders. Precision workholding is accomplished with a hydraulically expanded mandrel filled with a light grease or heavy oil. It exerts even pressure throughout the bore of the beryllium copper workpiece which it supports and drives.

Hampton, W. H. and W. Raymond Shaw
ECONOMICAL, ACCURATE HOLE-MAKING IN EXOTIC METALS. Grinding and Finishing, v. 7: 38-39 (January 1961)
Use of diamond-impregnated core bits and compatible drill presses. Elimination of secondary finishing.

Hockett, John E.
RECENT RESEARCH IN METAL FORMING. Applied Mechanics Reviews, v. 15: 157-166 (March 1962)

Hollis, W. S.
THE MACHINING OF DIFFICULT-TO-DEFORM METALS. Engineers' Digest, v. 22: 97-105 (November 1961)
Use of high speed cemented carbide or ceramic tipped tools for cutting high strength, heat resistant stainless steels, Be, Mo, Ti and Nimonic alloys. Data are given for UTS, elongation, tool-chip interface temperature, tool life and optimum tool geometry.

Jones, Alfred G.
MACHINING FOR MACH 3+ STRUCTURES. Space/Aeronautics, v. 34: 97-99, 101, 103 (November 1960)
Chipless and conventional machining, splice-welding, etching, pocketing by electrolytic, electric discharge and chemical milling of high strength materials for aircraft structural components to improve tolerances and surface finish.

Julien, H. Paul, Philip R. Thomas and George W. Thomson
NEW GRIT GRINDS TOUGH ALLOYS. American Machinist/ Metalworking Manufacturing, v. 105: 62-63. (December 1961)
Grinding of Be, hardened V steel and toolsteel using fused alumina abrasive with improved resistance to breakdown and longer retention of sharpness.

Kobrin, C. L.
TECHNOLOGICAL EXPLOSION IN FORMING. Iron Age, v. 188: 153-160 (October 1961)
A brief review of forming techniques, equipment and applications. The use of explosive, hydroelectric, magnetic, gas, contour and radial draw forming, cold and hot extrusion, shear spinning, electroforming, plasma-jet spraying, rolling under an atmosphere, ardeforming and ausforming in the production of aircraft, missile and other components from high strength and refractory metals.

Kobrin, C. L.
NEW TECHNIQUES IN METAL FORMING. Iron Age Metalworking International, v. 1: 13-15 (June 1962)

Kunkler, William C., Jr. and Jose R. Canal
FORGINGS FOR MISSILES AND SPACE VEHICLES. Mechanical Engineering, v. 83: 45-49 (September 1961)

Magor, Lincoln S.
TRACER MACHINING BERYLLIUM. Modern Machine Shop, v. 33: 130-133 (February 1961)
Tracer turning of Be using hydraulic tracer attachments for use with engine lathes and vertical turret lathes.

Mazza, Edmund
HYDROSTATIC-ISOSTATIC FORMING. Precision Metal Molding, V. 20: 38-41 (April 1962)
Temperature, time and pressure effects on density, ultimate tensile strength, yield, elongation, hardness, microstructure, crystal structure and grain size of QMV Be powder. Application to cladding of nuclear fuel elements.

Miller, Bernard S.
"EXOTICS" MOVE AHEAD. Metalworking, v. 17:11-13, 28-29 (October 1961)

McIntosh, A. B. and T. J. Heal, eds.
MATERIALS FOR NUCLEAR ENGINEERS. Interscience Publishers, Inc., New York, 1960, 379 p.
"Materials information on Be in nuclear engineering and with eight specific materials: . . . . beryllium . . . ."

MacPherson, B. M. and W. W. Beaver
NEW DEVELOPMENTS IN BERYLLIUM JOINING. American Welding Society, 43rd Annual Meeting, April 1962.

Prenguber, Donald and J. B. Mohler
CHEMICALLY MILLED FINISHES. Machine Design, v. 34: 132-134 (March 1962)
Surface finish and depth of cut data for wrought ferrous and Al alloys, refractory metals and alloys and superalloys after acid and alkaline milling.

Ridings, J. B. and N. S. Angus
EXPERIMENTS ON THE REVERSE IMPACT EXTRUSION OF CERTAIN METALS. Institute of Metals, Journal, v. 90: 107-113 (December 1961)
Reverse extrusion tests on metals including a commercial Al, H-10 and H-15 Al alloy, ETPHC Cu, brass, Zircaloy 2, commercial Ti and En56D, En58E and En58D stainless steels. Determination of the variation of maximum punch pressure with reduction in area. Study of the relationship between extrusion pressure and dynamic yield strength, the relationship between hardness and punch pressure and the effect of preheating slugs on punch pressure. Hardness data are given for extruded components with dynamic stress/strain curves.

Runnalls, O. J. C.
STUDIES ON PLUTONIUM AT CHALK RIVER. Chapter 7 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Ill., 1961, p. 70-78.

Shenoi, B. A., K. Vijayalakshmi and K. S. Indira
CHEMICAL MILLING. Current Engineering Practice, v. 4: 4-7 (January 1962)
Process sequence for chemical milling of Al and Al alloy sheet of formed parts in a 10-15% sodium hydroxide solution at 195°F. Review of cleaning, masking, curing of the maskant, scribing, etching and maskant removal techniques. Consideration of metal removal rate and etched area uniformity, corrosion resistance and hydrogen embrittlement. Costs and applications.

Sparling, Ken
NEW MACHINING METHODS NEEDED FOR HEAVIER SPACE-AGE METALS. SAE Journal, v. 69: 74-76 (March 1961)
Machining of Ti, Mo, Be, Ta, W, L-605 Co alloy, R-235 Ni alloy. A-286 alloy, H-11 toolsteel, 17-4 Mo steel and Thermold-J by electric spark discharge, electron beam machining, electrolytic grinding, ultra-high speed machining, chemical milling and thermal machining. High precision finish is obtained in all cases.

Tatman, M. E.
PROCESSING BERYLLIUM. Aircraft Production, v. 23: 466-470 (December 1961)

Tetzloff, Karl
THIN METAL PARTS. Machine Design, v. 34: 184 (February 1962)
Rubber die blanking of Be-Cu, high (75%) Au and 3003-H14 Al alloy disk stock into intricate parts with etching by saturated NaOH and concentrated HCl to remove the captive part from the disk.

Throner, G. C. and I. Lieberman
STAMPINGS FOR THE SPACE AGE... BY EXPLOSIVE FORMING. Tool and Manufacturing Engineer, v. 46: 123-126 (May 1961)
High-strength steels (Tricent, Vasco-jet-1000, AMS-6434), Unitemp M-252 alloy, AISI 6434 steel, AISI 4340 steel, 6Al-4V Ti alloy, Mg, Al and Al alloys are explosively formed, forged and trued. Explosive compaction is done on powdered ZrO_2, Ta, W, Mo, tungsten carbide with binder, Ta carbide, Be and other refractory metals.

Tilsley, R. and F. Howard
COLD EXTRUSION OF FERROUS AND NONFERROUS METALS. Machinery (London), v. 97: 1286-1293 (December 1960)
Extrusion of Al, Zn, Cu, Mg, Be, Md, Sn, Pb, EC-60 steel, low carbon and toolsteel and nodular cast iron using high carbon, high Zr-Cr toolsteel punch and die. Yield stress and tensile stress of extruded material.

Toczko, George A. and Ken Breeze
WORKING BERYLLIUM. American Machinist/Metalworking Manufacturing, v. 104: 115-126 (October 1960)

Wick, Charles H.
EXPLOSIVE AND OTHER HIGH-ENERGY-RATE FORMING METHODS. Chapter 16 from CHIPLESS MACHINING. Industrial Press, New York, 1960, p. 435-485.
Explosive, shock wave and gas pressure forming methods as applied in aircraft and missile industry on high-temperature, high-strength materials. Data are given for critical impact velocity and formability and work hardening capacity of materials. Tooling for explosive forming.

Williams, Lynn A. and C. R. Stroupe
TURNING-BREAKTHROUGH FOR ECM. American Machinist/ Metalworking Manufacturing, v. 106, No. 15:73-76 (July 23, 1962)
Turning, facing, grooving, trepanning, drilling and contouring using electrochemical machining in which work rotates and the electrode is stationary in a 3000 ampere electrolytic lathe. Data are given on lathe design, metal removal rate and efficiency.

Williams, L. R. and P. B. Eyre (United Kingdom Atomic Energy Authority, Springfields, Lancs. Eng.)
BERYLLIUM. Materials for Nuclear Engineers, p. 269-318. A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc. 1960.

Wood, W. W., R. E. Goforth and R. A. Ford
A PE SPECIAL REPORT ON THEORETICAL FORMABILITY. Product Engineering, v. 32: 71-83, October 1961
Design charts are used to predict sheet metal forming failures by splitting or buckling. Forming methods include brake forming, deep drawing and spinning, dimpling, rubber stretch and shrink flanges, joggling, linear stretch heel-in, sheet stretch and beading rubber press. Sheet materials include Al, Ti, Mg, Be, V, Cb, Mo, W and Ni alloys and supperalloys.

American Machinist/Metalworking Manufacturing, v. 105: January 1961, p. 69-70.
CONTOUR MACHINING BERYLLIUM.
Turning, boring and gun drilling operations in solid Be billets for making throat nozzles for a Mach 10 wind tunnel with high surface finishes and 0.0002 in. tolerances.

American Machinist/Metalworking Manufacturing, v. 105: March 1961, p. 80.
SPARK FORMING WORKS ON STAINLESS.
Flat blanks or tubes of Al, Ti, stainless steel, mild steel, high-strength steel, Cb, Be-Cu alloy and epoxy are shaped into dies by

electrospark forming under water. A high-voltage spark creates a shock wave which forms the workpieces.

Australasian Manufacturer, v. 46: 60-62 (June 1961)
DRILLING AND REAMING BERYLLIUM.
Techniques for conventional hole drilling, deep-hole drilling and gun drilling. Modification of geometry of solid carbide or carbide tipped tools.

Ceramic Age, v. 76: 25-26 (December 1960)
BeO AT NATIONAL.
Accurate and dust free methods of machining BeO, metal-ceramic combinations and high-purity Hf, Al and Th oxide shapes after fusion and ultrasonic cleaning.

Diamond Data, v. 3, no. 3: 2p. (1962)
ELECTROLYTIC GRINDING.
Use of diamond grit, metallic matrix and electrolyte for the electrolytic grinding of temperature sensitive and high tensile strength materials. Process description and metal removal rates are given.

Iron Age, v. 186: 110-111 (December 1960)
NEW PROCESSES CHALLENGE OLD.
A review of new machining techniques such as electrolytic grinding, electromachining, chemical milling, electrodischarge machining to keep pace with the development of tool and die steels, refractory metals, cermets, ceramics and other materials.

Iron Age, v. 186: 115-117 (December 1960)
HAVE YOU CONSIDERED ALL FORMS OF ELECTRICAL MACHINING.
Basic principals and applications of electro-discharge machining and electrolytic grinding. Typical parts that can be machined with little difficulty include carbide die blade roots and other hard workpieces.

Iron Age, v. 188: 107 (October 1961)
ACTION IN BERYLLIUM.

Iron Age, v. 188: 88-89 (October 1961)
HOW NON-CHEMICAL EXPLOSIONS SHAPE HARD-TO-FORM METALS.
Electro-hydraulic operating principles and procedures for capacitor-discharge plant equipment used to form, weld, bond and pierce ceramics and metals including Al, Ti, Be, Co and stainless steel.

Iron & Steel, v. 35: 139 (April 1962)
MACHINABLE STAINLESS STEEL CARBIDE.
Composition, corrosion, wear and heat resistance, physical and mechanical properties and machinability of Ferro-Tic S45 and Ferro-Tic S55 toolsteels.

Light Metal Age, v. 19: 18 (June 1961)
FABRICATION OF BERYLLIUM AND TITANIUM FOR THE SPACE CAPSULE.

Light Metal Age, v. 19: 25 (December 1961)
ELECTRIC DISCHARGE DRILLING BERYLLIUM.
Spark erosion machining of high-purity, pressed block to reduce the possibility of breakout. Finishing, tolerance and removal rate are controlled by current flow and firing rate.

Machinery (London), v. 99: August 1961, p. 442-443.
METHODS EMPLOYED FOR MACHINING BERYLLIUM IN AN AMERICAN PLANT.
A gyro gimbal is trepanned by the electrodischarge process and a large ring is machined by a carbide-tipped trepanning tool on a vertical turret lathe. Effective cutting speeds and feed ranges are given.

Materials in Design Engineering, v. 53: April 1961, p. 128-132.
INTRODUCTION TO CHEMICAL MILLING.
Recommendations for solution agitation, template size, thickness tolerances and surface areas to use in chemical milling. Methods of increasing uniformity of metal removal.

Metal Progress, v. 79: January 1961, p. 66.
HIGH-TEMPERATURE ALLOYS USED FOR TOOLING.
Waspaloy mandrel used for hot extrusion of beryllium; extrusion dies made from A-286 used for forming of beryllium nickel.

Metal Progress, v. 80: November 1961, p. 10.
BERYLLIUM CORP. DEDICATED NEW PLANT.
Details of the largest piece of Be machined in such a thin section. The part is produced at a new plant of the Brush Beryllium Corp., Cleveland, Ohio.

Metal Progress, v. 81: January 1962, p. 9.
ELECTROHYDRAULIC PROCESS SHAPES HARD-TO-FORM METALS.
Ti, Cb, stainless steel, W and Be parts up to 20 in. wide and 3/32 in. thick can be formed into required shapes. The equipment uses electric arcs instead of chemical explosives.

Metal Progress, v. 81: May 1962, p. 10
STRUCTURAL FORMS MADE FROM BERYLLIUM SHEET.
Angles, channels and Z shapes can be roll formed from Be sheet for structural parts for aerospace applications. Available now in 18-in. lengths, these structural shapes will ultimately be produced in lengths up to 6 ft.

Metalworking Production, v. 105: January 1961, p. 56.
ELECTRO-MACHINING BERYLLIUM.
Electrical discharge machining of Be by a process in which the work is the anode and a spark is created between it and the cathode, the latter being a low-density tungsten electrode infiltrated with Ag. Trepanning techniques as a means of salvaging Be as solids rather than chips.

Metalworking Production, v. 105: February 1961, p. 56.
HINTS ON TURNING BERYLLIUM.
Techniques and equipment used in turning or threading Be metal with carbide-tipped single-point tools.

Metalworking Production, v. 105: May 1961, p. 49-50.
HE SPARK-FORMING MOVES INTO PRODUCTION.
High energy electrospark process is applied to instantaneous formation of Al, stainless and high strength steel, Ti, Cb and Be-Cu missile and automotove parts, using a high voltage, underwater discharge to force the metal into the die.

Metalworking Production, v. 105: 52-53 (April 1961)
DRILLING AND REAMING BERYLLIUM.
Deep hole and gun drilling of Be using carbide tipped or solid carbide tools to increase tool life and decrease the tendency of Be to seize the tool.

Reactor Core Materials, v. 3: 51-60 (August 1960)
SPECIAL FABRICATION TECHNIQUES.
Melting, casting, hot working, cladding, diffusion bonding, extrusion, explosive forming, brazing, welding and nondestructive testing of reactor core materials such as Zr, U, Cb, ceramic coatings and Mo.

Reactor Core materials, v. 4: 52-68 (August 1961)
SPECIAL FABRICATION TECHNIQUES.
Ta, Cb, Pu, Zr, Fe, W, Ti, Cr and Ni-based alloys are fabricated into nuclear reactor components by melting, casting hot working, rolling, swaging pressure bonding, diffusion bonding, co-extrusion, canning, plating, welding, brazing and explosive forming.

Steel, v. 148: 86-88 (June 1961)
HOW EXPLOSIVES FORM SPACE AGE PARTS.
Common steels, stainless steels, Ti, Al, Tricent, Vascojet 1000, AMS 6434, Unitemp M-252 and Mg are cut, swaged, flattened, pierced, contoured and clad. Zinc oxide, Ta, W, Mo, tungsten carbide, tantalum carbide, and Be powders are compacted.

Steel, v. 149: 70-73 (August 1961)
HOW AC SPARK PLUG MACHINES BERYLLIUM.
Review of machining parameters used in turning, boring, threading, milling, grinding and deburring of Be to produce precision gyroscope parts.

Welding and Metal Fabrication, v. 29: 101 (March 1961)
METAL FATIGUE AND COLD EXTRUSION.

Western Machinery and Steel World, v. 52: 54-56 (May 1961)
ULTRA PRECISION INSPECTION FOR MANUFACTURE OF SPACE AGE INSTRUMENTS.
Fabrication of ultra precision inspection instruments, including air bearing and Be spacers. Dimension control through use of comparators, electronic gages, interferometers and profilometers.

AERE-M-443
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England
CUTTING IRRADIATED BERYLLIUM. M. H. Delve. June 1959.
An underwater cutting machine is used for sectioning specimens irradiated to 6 curies activity.

ARB-10706
BERYLLIA. A REPORT BIBLIOGRAPHY. June 1962. 20p.

ASD-TR-61-191(2)
Aeronautical Systems Div., Air Force System Command, Wright-Patterson Air Force Base, Ohio.
THEORETICAL FORMABILITY. APPLICATION. August 1961, v. 2, 474 p.
Correlation of theoretical formability data with actual forming operations on sheet composed from HM21XA-T8 Mg-Th alloy, 2024-0 Al alloy, 17-7 PH, PH15-7 Mo, Am-350, A-286 and USS-12-Mo-V stainless steels, 6Al-4V and 13V-11Cr-3Al Ti alloys, Vascojet 1000 (H-11), Rene 41, Inconel X, Hastelloy X, L-605 and J-1570 Co base alloys, Mo (.5% Ti) alloy, Be and W.

ASM Paper 61-AV-13
ADVANCED FABRICATION TECHNIQUES. R. Garcey, J. Glyman and E. Green, 1961, 19p.
Advantages, applications and economics of filament winding, explosive forming and furnace brazing techniques used in fabricating missile components.

ASME Paper 61-PROD-12
A REVIEW OF METAL-PROCESSING LITERATURE--METAL CUTTING PRACTICES. J. R. Roubik, A. L. Pickrell, K. H. Moltrecht, R. L. Vaughan, J. A. Sweeney and E. J. Weller. p. 5-7. 1961.
Tool-machine control systems, health and safety precautions during machining of Be, nonmachining metal removal processes (chemical milling, ultrasonic machining, etc.) and machining conditions for superalloys, ultrastrength alloys, Zircaloy 2, graphite, Mg, Mo and U.

ASME Paper 62-PROD-12
ANODE CUTTING--SCIENCE, ART AND SKILL. Lynn A. Williams. 1962, 8 p.
Survey of anode cutting (also referred to as electrochemical or electrolytic machining) methods. Theoretical removal rate for thirteen metals. The process provides various metallic shapes depending on the shape of the electrode. Effects of electrode configuration on penetration rate and cutting rate. Effects of salt-mist atmosphere on rusting.

DMIC MEMO 75
Defense Metals Information Center, Battelle Memorial Institute
REVIEW OF SOME UNCONVENTIONAL METHODS OF MACHINING. Francis W. Boulger. November 1960, 20p.
Review of methods used for processing high strength and temperature resistant materials, including electrical-discharge machining, electrolytic grinding, electrolytic machining, chemical milling, ultrasonic machining, electronbeam machining, plasma-arc cutting. Most of these methods develop low mechanical forces and are useful for processing fragile or flimsy workpieces also.

NAA-SR-6453
Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
SEMI-CONTINUOUS HOT PRESSING. J. D. McClelland and E. H. Zehms. November 1961, 14 p. (Contract AT-11-1-GEN-8)
Description of techniques and apparatus used in semicontinuous hot pressing. Effect of time and temperature on the final density of high purity beryllia at 1100° C.

NP-9375
Beryllium Corp., Reading, Penna.
DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. PHASE I. First Interim Technical Report for August 24, 1960-September 24, 1960. B. H. Hessler and E. E. Weismantel. 33p. (Contract AF 33(600)-41959)

Methods for producing various structural shapes from beryllium by roll-forming are reviewed. Those factors in billet and strip production (through the deformation and thermal process) which might affect properties of roll-formed shapes are discussed. (C. J. G.)

NP-11184
Beryllium Corp., Reading, Penna.
DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. FINAL PHASE III REPORT. Fourth Interim Technical Report, May 19-November 13, 1961. E. E. Weismantel and K. C. Taber. 66 p. (Contract AF 33(600)-41959)

Production of round and square solid shapes through simple roll reduction of previously extruded shapes. Formation of angles, channels and zees by bending. Effects of the forming process on the ultimate tensile strength, yield strength and elongation.

ORNL-2988 (P. 283-430)
Oak Ridge National Lab., Tenn.
METAL FORMING AND CASTING. R. J. Beaver, W. J. Kucera, et.al.

". . . (3) beryllium tubing and uranium monocarbide arc-melted shapes for high-temperature systems."

Patent - British 848,269
IMPROVEMENTS IN OR RELATING TO THE FORMING OF BERYLLIUM. Nigel Austin Hill (to United Kingdom Atomic Energy Authority). September 1960.

Beryllium, a brittle material easily oxidized in air above 750° C, can be formed in air below 750° C by supporting with a ductile metal to which beryllium will adhere without welding. The ductile metal should be mild steel of twice the thickness of the beryllium to be formed, and the forming operation should be carried out at 630 to 670° C. Steel or aluminum alloys can also be employed as the ductile metal. Three examples are given of cupping a beryllium disk, pressing a beryllium sheet into a square dish, and bending a beryllium strip at right angles. Beryllium sheet up to 0.080-in. thick can be formed in this way. (D. L. C.)

Patent - British 868,064
EXTRUSION AND DRAWING OF BERYLLIUM. John Frederick Sackman, Frank Trowell and David Brian Wright. (United Kingdom Atomic Energy Authority). May 17, 1961.

Electrodeposition of Au or Ag on Be to provide a protective layer to prevent contact with the die during drawing and extruding. Data are given for process speeds and metal temperatures.

TID-11535

Superior Tube Co. , Norristown, Penna.
THE CONVERSION OF EXTRUDED BERYLLIUM TUBING TO A CLOSE TOLERANCE BORE TUBE. LABORATORY REPORT 1812. A. C. Hood and A. M. Bpunds. February 1960. 133p. For Oak Ridge National Lab. (Contract 13X-80025)

Includes Appendices: B. THE TROUBLE WITH BERYLLIUM. J. Sawkill. C. NITRIC FUME SCRUBBING. O. J. Jones and J. Sullivan (Tube Investments, Ltd. Technological Centre, Walsall, Staffs, England). October 1959.

Beryllium tubing is hot extruded from pre-sintered and machined billets to sizes from 0.025-in. OD by 0.030-in. wall to 2.0-in. OD by 0.250-in. wall. The extruded tubing is warm bore sized by pulling a mandrel through the tube, to attain close tolerances. A finished tube measures 0.375 ± 0.008-in. OD by 0.040 ± 0.001-in. ID. The bore sizing operation reduces the extruded tube yield by ~ 25%. The properties of the tubing were investigated by bending and internal hydrostatic proof testing at 1000 psi. Burst tests indicated that the tube will withstand 10,000 psi before failure where the surface was suitably polished chemically. Tubing texture studies revealed a preferred orientation with basal planes parallel to the longitudinal direction and situated radially out from the center of the tube; resulting in transverse properties lower than longitudinal properties. Metallographic studies revealed a precipitate in the supposedly pure metal which can be made to shift from the grain boundaries to the matrix by heat treatment.

SECTION V. BERYLLIUM METALLURGY

PART G. POWDER METALLURGY

Beaver, Wallace W. and Larson, Harold F.
THE POWDER METALLURGY OF BERYLLIUM. Brush Beryllium Co., Cleveland. (1961). "Powder Metallurgy" Werner Leszynski, ed. New York, Academic Press, 747-73 (1961).

Production of powder Be compacts and study of their shape, dimensions, contour, metallurgical properties, particle size and impurity content following sintering, vacuum hot pressing and mechanical deformation.

Bisson, Andre and Frisby, Henri
ELECTRON MICROSCOPE OBSERVATION OF POROSITY, CARBON INCLUSIONS AND DISLOCATIONS IN BERYLLIUM OXIDE SINTERED UNDER LOAD. Journal of Nuclear Materials, v. 4: 133-142 (July 1961) (French)

Replicas of fractured surfaces are studied for hot pressed specimens with porosity remaining from the sintering process, cavities or bubbles are observed resulting from prolonged heat treatment in air and oxidation of impurities in the specimens. Carbon precipitates deposited on dislocations are correlated with dislocation arrangements and bubble formation. 7 ref.

Budnikov, P. P. and Zvyagil'skii, A. A.
SINTERING OF BERYLLIUM OXIDE. Ogneupory, 26: No. 11: 523-30 (1961) (Russian)

Effect of temperature variation of BeO on the physical and mechanical properties so that optimum conditions for the manufacture of dense ceramic objects can be determined.

Butcher, J. and Martin, A. J.
A ROOM-TEMPERATURE AGEING EFFECT OBSERVED IN COMMERCIALLY PURE BERYLLIUM. Institute of Metal, Journal, v. 90: 191-192 (January 1962)

Cunningham, George W.
POWDER METALLURGY – THE STATE OF THE ART. Battelle Technical Review, v. 11, no 8: 3-9 (August 1962)

Review of techniques for producing cermets, billets, fuel elements, castings and wire from metallic and ceramic powders. Techniques include cold compacting, sintering, high energy rate and continuous compacting, isostatic pressing, plasma arc spraying, vibratory compacting, electrophoretic deposition and ultrahigh temperature and pressure processes.

Fischer, Roland B.
THE MAGNITUDE OF POWDER METALLURGY. Mines Magazine, v. 51: 21-22 (October 1961)

Consideration of powder composition; particle size, shape and structure; amount of pressure applied; and process temperature. Pressing, sintering, slip casting, dispersion hardening and transpiration cooling processes for consolidating such powders as Ni-P, stainless steel, Fe, Cu, Ni, Co, W, Mo, Pt, Cb, Ta, Re and Be.

Hausner, H. H.
PRESSURELESS COMPACTING AND SINTERING OF METAL POWDERS. Journal of Metals, v. 13: 752-758 (October 1961)
Comparison with pressure compacting with reference to density, particle deformation and contact, diffusion, lattice defects, stress and other characteristics. Vibratory compacting and slip-casting processes. 11 ref.

Hausner, Henry H. and Friedemann, Helen C.
BIBLIOGRAPHY ON POWDER METALLURGY IN NUCLEAR ENGINEERING. (1956-1960) Metallwerk Plansee Aktiengesellschaft: 119 (1961) Reutte/Tyrol, Austria.
Collection of 643 selected Be references, most of them annotated. References are taken from reports, magazine and book literature and cover foreign as well as English language sources.

Jenkins, I.
POWDER METALLURGY. Macchine, v. 16: 1241-1249 (December 1961) (Italian)
Fabrication and sinterizing of W, Cu, Ag, C, Ta, Fe, Mo, Be and Ni powders and application in making filters, bearings and drills. Determination of magnetic permeability, porosity and density of sinterized products.

Jenkins, I.
POWDER METALLURGY – A SURVEY. Metal Industry, v. 98: 351-354 (May 5, 1961)
Metallographic examination of Cu, Ta, W, Ag, Pb, Be and C particles formed by electrolysis, atomization, thermal dissociation or reduction to determine particle size and distribution, particle shape, density, packing, molding and chemical properties.

Judge, John
BERYLLIDES BOOST TEMPERATURE LEVEL. Missiles and Rockets, v. 9: 36-37 (November 6, 1961)
Powder metallurgical production of $TaBe_{12}$, Ta_2B_{17}, $CbBe_{12}$, Cb_2Be_{17}, $ZrBe_{13}$ and Zr_2Be_{17} by cold and isostatic pressing, sintering, extrusion, slip casting, diamond grinding and flame spraying. Evaluation of oxidation resistance, specific gravity, modulus of rupture and tensile strength for beryllides used in missile components.

Kjellgren, Bengt R. F.
STATUS OF THE BERYLLIUM INDUSTRY IN THE UNITED STATES OF AMERICA. Paper from "Symposium on Light Metal Industry in India". National Metallurgical Laboratory, Jamshedpur, India: 57-67 (1961)

Kolomoitsev, F. I., Izotov, V. P. and Stauer, E. V.
THE LUMINESCENCE OF POWDERED PHOSPHORS IN AN ELECTRIC FIELD. Optics and Spectroscopy, v. 12: 64-65 (January 1962)
Investigation of the effect of electric field, voltage and current on the luminescence intensity for powdered phosphors including ZnS, Zn and Cd sulphides activated with Ag or Cu, Zinc silicate, mixed silicates of Ca and Be, Ca and Mg tungstates, halophosphates of Ca and Cd, magnesium arsenate, calcite, fluorites, and the effect of solution treating these materials with Rochelle salt, soldium silicate, potassium iodate and others. 10 ref.

Leszynsk, Werner
FOURTH INTERNATIONAL PLANSEE SEMINAR. (Held in Tyrol, Austria, on June 20-24, 1961). Journal of Metals, v. 13: 746-751 (October 1961)
General subject of "Powder Metallurgy in the Nuclear Age" includes sintering theory, two-component systems, dispersion strengthening, reactor fuel materials, properties of uranium carbides and oxides, uranium nitride, boride and Tn, Pu and Be and surveys of high-melting metals including W, Ir, Mo, Ta, Cb and Ru and of pre-alloyed powders.

Levinson, David W.
FIBER-REINFORCED STRUCTURAL MATERIALS. Machine Design v. 34: 147-148, 150 (March 29, 1962)
Reinforcement of elastomers, plastics, ceramics and metals with fibers of glass, plastics, metals and ceramics and its effect on tensile strength, thermal shock resistance, stability and magnetic properties.

Loewenstein, Paul
THE EXTRUSION OF BERYLLIUM. Current Engineering Practice, v. 4: 16-20 (February 1962)
Hydrostatic pressing, rolling and extrusion of Be powder with subsequent canning of the billet with carbon steel. Analysis of extrusion forces and metal flow mechanisms. Data are given for preferred orientation and ductility as a function of the extrusion ratio. Comparative microstructures are given showing the relative grain size of extruded and cast Be.

Loewenstein, P., Aronin, L. R. and Geary, A. L.
HOT EXTRUSION OF METAL POWDERS. Paper from "Powder Metallurgy". Metallurgical Society of AIME. Interscience Publishers, Inc., New York 1: 563-583 (1961)
Hot extrusion is a practical method of consolidating and shaping metal powders into long lengths of various cross sections. It generally yields superior physical properties and is at present used as the production method for a number of Al-base alloys. For other metals, however, hot extrusion is still in the laboratory stage.

Muvdi, B. B.
INTERNAL STRUCTURES OF ROLLED, PRESSED AND EXTRUDED BERYLLIUM COMPACTS. Digested from "Structural Beryllium", Paper no. 79 presented at the 63rd Annual Meeting ASTM, June 1960 Metal Progress, v 82: 140, 142, 144 (July 1962)
Compacts of Be powder were fabricated by five different processes; upsetting while hot gives the best combination of properties and is superior to hot pressing and random rolling.

McClelland, J. D.
KINETICS OF HOT PRESSING. Atomics International, Canoga Park, California (1961) p. 157-71 of "Powder Metallurgy" Werner Leszynski, ed. New York Academic Press, 1961.
Analysis of hot pressing kinetics in terms of a plastic flow model for sintering. Investigation of the end point density, viscosity, yield point and densification rate of powdered beryllia compact as a function of temperature and pressure by hot pressing under applied hydrostatic pressure at 1200-1700°C.

McClelland, J. D.

A PLASTIC FLOW MODEL OF HOT PRESSING. American Ceramic Society, Journal, v. 44: 526 (October 1961)

The hot pressing of ceramic powder is described using a model for sintering in which small, isolated, spherical pores close by surface tension, the energy dissipated during viscous flow being equated to the work done in closing with a differential equation giving the rate of densification in terms of a viscosity and a yield point. Correlation is made with data for experimental hot pressing of beryllia at 1200-1700°C for 15-250 min at 2000 psi pressure.

McClelland, J. D.

ADVANCED TECHNIQUES IN HOT PRESSING. (Abstract of paper 2-11s-62 presented before American Ceramic Society), American Ceramic Society Bulletin, v. 41: 315 (April 1962)

Continuous hot pressing with control of temperature and pressure used for obtaining high density and controlled grain size in fabrication of translucent beryllia and alumina bodies. Samples exhibit substantial improvement in high temperature physical properties. Comparison with properties obtained by cold pressing and sintering.

McClelland, J. D. and E. H. Zehms

SEMI-CONTINUOUS HOT-PRESSING MAKES HIGH-DENSITY CERAMICS. Space/Aeronautics, v. 37: 131-132 (May 1962)

Description of a technique for hot pressing of beryllia and alumina with a magnesia additive lower than 550°C. Determination of effects of pressing temperatures, up to 1700°C and pressing times, up to 20 min on the density of the resultant ceramic body.

Nakatani, Hiroshi

STUDIES ON SINTERING OF BERYLLIUM POWDER. PT. 3. PRETREATMENT OF BERYLLIUM POWDER FOR SINTERING. Electrotechnical Laboratory, Bulletin, v. 25: 636-637 (August 1961) (English)

Specific gravity method using ethylene dibromide-benzole mixed solution is used to separate the impurities mixed into the Be powder during mechanical reduction of the fused salt electrolytic flakes or the particle control process. Concentrated HNO_3 is used to refine the particle surface. Spectral analysis.

Nakatani, Hiroshi

STUDIES ON SINTERING OF BERYLLIUM POWDER. PT. 3. THE PRETREATMENT OF BERYLLIUM POWDER FOR SINTERING. Denki Shikensho Iho, v. 25: 605-10 (August 1961) (Japanese)

Use of ethylene dibromide-benzole solution for the gravity separation of impurities in Be powder. Refinement of the particle surface by concentrated HNO_3.

Ryshkewitch, Eugene

METAL-OXIDE CERAMICS. International Science and Technology: 54-61 (February 1962)

Fabrication by sintering at 1600-2800°C with data given for physical and mechanical properties including tensile strength, dielectric constant, electrical conductivity, Poisson's ratio and ductility. Industrial application and metallurgy of alumina, beryllia, magnesia, thoria, titania, urania and zirconia. Processing and properties of cermets composed of combining Be, Cr and W with oxides.

Schifferli, L. M.
SLIP CASTING: A GOOD WAY TO SHAPE DIFFICULT MATERIALS. Materials in Design Engineering, v. 51: 108-109 (Dec. 1960)
Design considerations for engineering metals, refractory metals, refractory metal compounds, mixtures and nonmetallics. Thin-wall closed-end tubes or complex shapes having re-entry angles, now beyond the capabilities of even the most advanced powder metallurgy methods, are particularly suitable for slip casting.

Tatman, M. E.
PROCESSING BERYLLIUM. Aircraft Production, v. 23: 466-470 (December 1961)
Physical and mechanical properties of machined, hot pressed, extruded and isostatic pressed Be powder. Experiments on shear forming, explosive forming and hot spinning and methods for joining Be to itself and other materials including brazing, welding, bonding and mechanical fastening.

Thomson, R.
HOT HARDNESS TESTING APPLIED TO THE AGEING AND HEAT TREATMENT OF BERYLLIUM. Journal of Less-Common Metals, v. 3: 170-178 (April 1961)
Sections from extruded rod, produced from thermally reduced pebble metal ingot and from electrolytically reduced flake material are tested at up to 600°C. Pebble metal exhibits both strain aging and precipitation hardening mechanisms, which are removed by precipitation annealing at 600-800°C. with consequent improvement in ductility. No such phenomena are detected in flake metal. 4 ref.

Townhill, A.
BERYLLIUM DESCRIBED AS TRUE SPACE AGE METAL. Metals Review, v. 34: 22-23 (January 1961)

Wikle, K. G. and Potter, V. C.
BERYLLIUM PROCESSING BY POWDER METALLURGY. Journal of Metals, v. 13: 537-544 (August 1961)
Description of the vacuum hot pressing process, including operational techniques required for high quality control and other techniques employed in powder processing and fabrication of hot pressed billets.

Iron Age, v. 188: Dec. 14, p. 111-113
ADVANCED FORMING TECHNIQUES SPUR BERYLLIUM USAGE.
Hot pressing of Be powder, extrusion of steel clad Be billets and Mn cored billets and forging of hot pressed Be for producing complex shapes and structural parts with improved mechanical properties. Evaluation of strength properties of forgings and billets.

Iron Age Metalworking International, v. 1: Feb. 1962, p. 32-34
METALLURGISTS REPORT PROGRESS IN FORMING BERYLLIUM.

Machine Moderne, v. 55: Nov. 1961, p. 49-50. (French)
ELECTRON BOMBARDMENT

Metal Powder Industries Federation, v. 17: 1961, 195 p., 60 E. 42nd St., New York 17, N. Y.

PROGRESS IN POWDER METALLURGY.

Papers presented at a conference held at Cleveland, Ohio, Apr. 24-26, 1961. Topics include compacting, sintering, fabrication, heat treatment and resulting physical and mechanical properties, structures and applications of powders of Be, Fe, Cu, Ti, brass, Ni, Mo, Cb, Ta, W, Co, Al, Mn, Cr, Pb, Zn, Ag, C and their alloys, ceramics and cermets and stainless, alloy and carbon steels. Papers are abstracted separately.

Nature, v. 189: February 4, 1961, p. 365-367.

POWDER METALLURGY.

Review of the history and techniques of powder metallurgy, including mechanisms of the sintering process and methods of hydrostatics and isostatic pressing, slip casting, hot extrusion, rolling, explosive pressing, blow forging and dispersion hardening.

Precision Metal Molding, v. 20: February 1962, p. 40-41

ISOSTATIC PRESSING.

High pressure Ar gas in an electrically heated cylindrical cell is used to compact Be, W, Mo, Cb, stainless steel and other hard to fabricate materials into tubing and shapes at 100% of theoretical density.

Steel, v. 149: November 6, 1961, p. 90

BERYLLIDE FAMILY HEADED FOR PLEIADES

AAEC/E-80

Australia Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales.

A COMPARATIVE STUDY OF TWO GRADES OF BeO. K. D. Reeve and E. J. Ramm. November 1961 33p.

AD-258241

Wright Air Development Div., Nuclear Metals Inc. Dec. 1960, 104p.

DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F. M. Yans.

Relation of specimen geometry and rolling sequence on texture development. During rolling, the basal plane population parallel to the plane of Be sheet increases with reduction in area. Rolling and annealing tests on bi-directionally rolled sheet demonstrate that when the sheet is subjected to annealing temperatures of over 950°C. the location of the basal plane peak intensity is shifted and the intensity profile changes markedly.

AD-260313

Armour Research Foundation, Chicago, Ill.

DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES.

Study of sintered alloys composed of Be dispersions in a ductile Al matrix. Effects of variations in the sintering process on mechanical properties of the alloy.

AD-263678

Armour Research Foundation, Chicago, Ill.
DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES. Frank A. Crossley.

Development of ductile Be composites, consisting of Be particles in a ductile matrix, using pressure liquid-phase sintering in vacuum tensile properties and hardness of matrix alloys from the Ag-Al system.

AD-266424

Armour Research Foundation, Chicago, Ill.
DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES. Frank A. Crossley and R. J. Van Thyne, Nov. 17, 1961, 3p. (Rept. no. ARF 2212-5) (Contract NOw 61-0370-c).

Development of ductile composites consisting of Be particles in a ductile matrix of compositions selected from the Ag-Al system. Relatively large compacts are made for tensile testing.

ARB10706

BERYLLIA—A REPORT BIBLIOGRAPHY. June 1962, 20 p.

A review of literature published between 1957 and June 1962, covering studies made on the hot pressing, analysis, sintering, fabricating and coating of beryllia.

ARD-2187-4

Armour Research Foundation, Illinois Inst. of Tech., Chicago
DUCTILE BERYLLIUM ALLOYS. Frank A. Crossley and R. J. Van Thyne. (May 18, 1960)

Tests using powder metallurgy procedures, including production of ductile Be alloys by liquid phase sintering; determination of sinterability of Al compacts containing Y or Ce and of Ag compacts containing Y, Ce or Ca; and cold pressing, annealing and cold rolling of Be-Al-Ge and Be-Ag-Ge compacts.

ARF-2187-5D

Armour Research Foundation, Illinois Inst. of Tech., Chicago.
DUCTILE BERYLLIUM ALLOYS. Frank A. Crossley and R. J. Van Thyne. Bimonthly Report No. 5. July 20, 1960, 15p. Contract Noas 60-6036-c (AD-240614)

An envelope type microstructure prepared by liquid-phase sintering is being investigated as a means of producing ductile beryllium alloys. Sinterability has been demonstrated previously for 25 vol. % matrix alloys of the Be-Al-Ge and Be-Ag-Ge systems, so efforts were directed toward developing alloys of lower matrix content. Previous work has given considerable evidence that matching hardness of the matrix with the principal phase is mandatory for high ductility compacts. Accordingly, quaternary additions for strengthening the matrix were investigated. The most promising alloy system is Be-Ag-Al-Ge. The hardening reaction in the silver-rich matrix of this alloy system is a peritectoid reaction $\alpha + \gamma \rightarrow \beta$. Slow cooling from above the peritectoid reaction temperature of 390°C, or quenching from above this temperature and aging below it, results in hardnesses up to three times higher than those achievable in the Ag-7.5 wt. % Cu age hardening alloy. Alloys of Be-Ag-Al-Ge systems nominally containing 10 and 15 vol. % matrix were liquid-phase sintered under pressure to eliminate voids. Pressure sintering apparently squeezed out some of the

matrix so that the resulting compacts contained less than 10 vol. % matrix and probably about 5 vol. %. The compacts were very tough. This was especially evident in abrasion cutting. Two compacts were cold reduced 60% although cracking initiated at 18% reduction. These alloys are standouts among those investigated to date. They show real promise.

LMSD-288233

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif. GRAIN REFINEMENT IN BERYLLIUM BY ALLOYING. D. Crooks and H. Sumsion. Technical Note [for period] July 1, 1958 through December 31, 1959. January 1960. 42p. Contract NOrd-17017 This paper was originally printed under the same title in Vol. II "Metallurgy and Chemistry," of General Research in Materials and Propulsion, January 1959-January 1960. LMSD-288140.

Previously published data on the effect of alloying upon grain refinement of cast beryllium is reviewed. Experimental procedure is described for producing beryllium alloy buttons in a vacuum-inert atmosphere arc furnace with non-consumable electrodes and water-cooled copper hearth. A method for evaluating grain refinement of the alloy buttons is described. Results of the evaluations are given.

NYO-2694

U. S. Atomic Energy Commission, Div. of Technical Information THE DEVELOPMENT OF URANIUM CARBIDE AS A NUCLEAR FUEL. H. S. Kalish, F. B. Litton, J. Crane, and M. L. Kohn. Nov. 30, 1961, 70p.

Investigation of the preparation of UC by powder metallurgy from the methane or propane reaction and by skull melting using a UO_2 and graphite reaction. Examination of sintering characteristics and physical properties and the effect of carbon content on thermal expansion and compatibility reactions with various metals.

NYO-10007

U. S. Atomic Energy Commission, Div. of Technical Information ULTRASONIC HOT PRESSING OF METALS AND CERAMICS William B. Tarpley and Herbert Kartluke, December 1961, 26p.

Plastic flow, strength, density, grain refinement, solid state diffusion and age hardening effects of ultrasonic hot pressing of Ag calcium fluoride and Al oxide powders. References to literature covering Ni alloys, U, Mo, uranium dioxide, uranium carbide, uranium nitride and uranium beryllide. 24 ref.

ORNL-3183

Oak Ridge National Lab., Tenn.
THE CALCINATION IN AIR OF BERYLLIUM OXALATE TRIHYDRATE TO BERYLLIUM OXIDE. R. L. Hamner and L. A. Harris. Oct. 19, 1961. Contract W-7405-eng-26. 16 p.

Study of phase and sinterability changes of high purity BeO powders obtained by calcining $BeC_2O_4 \cdot 3H_2O$ at 50°C. under continuous equilibrium heating conditions using differential thermal analysis, thermogravimetric analysis and room and high temperature X-ray analysis.

Patents, Belgian 569700

PREPARATION OF SINTERED BERYLLIUM OXIDE.
Commissariat a l'Energie Atomique. (Sept. 6, 1957). (French)

Be salt is added to $Be(OH)_2$ to obtain BeO which is sintered in graphite molt at 1300-1500°C. under 2100 psi. after mixing with a neutron-absorbing substance.

Patents, British 840857

METHOD OF PRODUCING SHAPED BODIES OF BERYLLIUM.
Trevor Robert Barrett, Geoffrey Courtnauld Ellis, and Ronald Andrew Knight (to United Kingdom Atomic Energy Authority). July 13, 1960.

A procedure is presented for the production of shaped bodies of Be by powder metallurgy. Beryllium powder of particle size not greater than 80 microns is placed into a mold and sintered, with no external pressure applied to the mold before or during sintering. The sintering is preferably effected in vacuo. The sintering should be carried out at a temperature of 1150 to 1250°C for about 6 hrs.

Patents, British 842226

IMPROVEMENTS IN OR RELATING TO METHODS OF PRODUCING MALLEABLE BODIES OF METALLIC BERYLLIUM. Harry William Dodds. (to Brush Beryllium Co.) July 20, 1960.

A method for producing bodies of metallic beryllium is reported. The method consists of charging powdered Be into a mold and subjecting the interior of the mold and the beryllium to a preliminary heat treatment and evacuation at a temperature below sintering temperature until absorbed gas and vapor have been removed. Then combined evacuation, heat treatment, and mechanical pressure are applied to the beryllium at temperatures ranging from that at which sintering begins upward to that which produces pronounced grain growth.

Patents, British 847231

IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF SINTERED BODIES. Alan Blainey (to United Kingdom Atomic Energy Authority). Sept. 7, 1960.

A method of producing shaped bodies of metals and electrically conducting metal compounds is outlined whereby the mass in a mold is heated by electric current and compressed, a substance being present which is vaporized during the heating and compacting processes. An example of the method is given in which a dense uranium rod is produced from uranium flakes ball-milled in oil and compacted in a silica tube closed with copper plungers. The oil is vaporized and furnishes an inert atmosphere, preventing oxidation of uranium. The method can be applied to other materials, e.g., beryllium flakes, tungsten powder, and hard metal carbide powders such as tungsten carbide. The heating process may be carried only to a point where sufficient local superficial softening of the particles occurs to fuse them together.

Patents, British 872714

IMPROVEMENTS IN SINTERING PROCESS. Ronald Andrew Knight. United Kingdom Atomic Energy Authority, (July 12, 1961).

Method for sintering of uncompacted metal powders such as Be by preheating in a mold having a core with a melting point above the presintering temperature but below the sintering temperature. When sufficient cohesion is obtained in the powder for retaining its shape without support, the core is melted away in the sintering process.

Patents, British 874129
IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF HOLLOW BODIES FROM METAL POWDER. Thomas James Davies. (to United Kingdom Atomic Energy Authority). August 2, 1961.
Loose sintering of Be powders to cracking during cooling and sintering at 1200°C. under axial end loading.

Patents, French 1206681
PROCESS FOR THE MANUFACTURE OF METAL INGOTS. (Sylvania-Corning Nuclear Corp.) Aug. 31, 1959.
An improved process is described for the manufacture of ingots of Be, or their hydrides.

Patents, U. S. 2917383
FABRICATION OF URANIUM-ALUMINUM ALLOYS. H. A. Saller (to U. S. Atomic Energy Commission). Dec. 15, 1959.
A process is presented for producing a workable article of a uranium-aluminum alloy in which the uranium content is between 14 and 70% by weight; aluminum powder and powdered UAl_2, UAl_3, UAl_5, or UBe_9 are mixed, and the mixture is compressed into the shape desired and sintered at between 450 and 600°C.

Patents, U. S. 2979399
PREPARATION OF COMPACTS MADE FROM URANIUM AND BERYLLIUM BY SINTERING. R. P. Angier (to U. S. Atomic Energy Commission). Apr. 11, 1961.
A powder metallurgical method for making high-density compacts of uranium and beryllium is reported. Powdered UBe_9 and powdered Be are blended, compacted, and then sintered by rapidly heating to a temperature of approximately 1220 to 1280°C in an inert atmosphere.

Patents, U. S. 3000734
SOLID STATE FABRICATION OF HARD, HIGH MELTING POINT, HEAT RESISTANT MATERIALS. Nicholas J. Grant and Claus G. Goetzel. Sept. 19, 1961.
Production of Ni, Co and Fe-base superalloys containing slip-inhibiting hard phases such as carbides, borides, silicides and nitrides of Cr, W, Mo, V, Cb, Ta, Ti, Zr and Hf or oxides of Al and Be. Process involves compacting, hot shaping and diffusion heat treatment. The alloys have high strength and creep resistance at up to 1000°C.

Patents U. S. 3009809
SINTERING OF IRON-ALUMINUM BASE POWDERS. Joseph Neri, Jr. November 21, 1961.
Preparation of Fe-Al base alloys containing up to 11% Al and a Mo, Cb, Ti, Be, Ni, Cr, Zn, Si or Sn additive by pressing, sintering, cold rolling and annealing. Process is used in the fabrication of intricately designed parts.

Patents, U. S. 3010825

PRODUCTION OF NEUTRON SOURCE MATERIAL. G. G. J. Michaud and R. B. Boucher. November 28, 1961.

Direct method of treating PuO_2 with Be metal powder to produce a sintered product having high neutron output efficiency.

SCNC-332

Sylvania Electric Products Inc. Sylcor Div., Bayside, N. Y.
THE FABRICATION OF BERYLLIUM BY HOT ISOSTATIC PRESSING AND BY IMPACT EXTRUSION. I. Sheinhartz. Sept. 1961. For General Nuclear Engineering Corp., Dunedin, Fla. Contract AT(38-1)-200, Subcontract 40-9-11. 42p.

Feasibility of producing a finned Be tube by the hot isostatic pressing of Be powder. Effect of the extrusion temperature and compact density on the mechanical properties of machined hot pressed Be billets and porous cold compacted billets extruded by the Dynapak.

SCR-302

Brush Beryllium Co., Cleveland, Ohio.
INVESTIGATION AND DEVELOPMENT OF METHODS FOR PRODUCING HIGH-POROSITY BERYLLIUM BODIES. B. B. Lympany, J. G. Theodore and W. W. Beaver. (Jan. 1960).

Investigation of production methods including use of volatilizable additives, application of aqueous foaming techniques at room temperature followed by sintering of the green shape, slip-casting of hollow spheres followed by sintering of randomly packed spheres; preparation of Be honeycombs by a combination of slip-cast, lost-wax method and utilization of fibrous Be chips for pressureless-sintered shapes.

TID-11045

Beryllium Corp., Reading, Penna.
PRODUCTION OF BERYLLIUM HYDROXIDE AND PREPARATION OF SINTER COMPACTS. QUARTERLY REPORT FOR JULY 1, 1960 THROUGH SEPT. 30, 1960.

Preparation of sintered compacts and spheroidal pellets of beryllium hydroxide, beryl ore, sodium fluosilicate and soda ash by hydrolysis and predensification of sodium beryllate.

WADC-TR-58-478(Pt. II)

Brush Beryllium Co., Cleveland.
DEVELOPMENT OF WROUGHT BERYLLIUM ALLOYS OF IMPROVED PROPERTIES. John G. Klein, Leslie M. Perelman, and Wallace W. Beaver. Period covered: July 1, 1958 to June 30, 1959. Sept. 1, 1959. 128p. Project 7351. USAF Delivery Order 33(616)-57-19.

Mechanical and physical properties are reported for extruded and/or rolled products fabricated from beryllium-rich alloys of silver, tin, cadmium, zinc, nickel, and copper, as well as beryllium fabricated from subsieve-size powder and powder of higher than normal beryllium oxide content.

WADD-TR-60-425

Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio.
MECHANICAL PROPERTIES OF BERYLLIUM. A. E. Riesen and R. T. Ault. Sept. 1960. 35p. (AD-249393)

SECTION V. BERYLLIUM METALLURGY

PART H. HEAT TREATMENT

Becket, F. J., and P. Burtenshaw
VACUUM HEAT-TREATMENT. Wild Barfield Heat-Treatment Journal, v. 8: 2-9 (June 1962)
Vacuum heat-treatment of brass, Fe and Ni alloys, stainless steels, Ti, Zr, U and Be in hot retort furnaces with mechanism and prevention of sublimation of alloying elements. Vapor pressure-temperature curves are given for twenty-one metals.

Becket, F. J., and P. Burtenshaw
VACUUM HEAT TREATMENT. Metallurgia, v. 65: 107-111 (March 1962)
Metallurgical and engineering aspects and furnace equipment for operations at 800-3000°C with reference to steel, stainless steel, Cd, Zn, Mg, Pb, Ag, Al, Cr, Be, Cu, B, Fe, Si, Au, Ni, Ti, V, Zr, U, Pt, C and Mo. Effects of pressure, water vapor, impurities, pumping speed and temperature on physical and mechanical properties of metals and on oxide formation.

Bland, Jay
WELDING OR BRAZING OF DISSIMILAR METALS. Product Engineering, v. 31: 46-49 (December 1960)

Brown, A. B., A. J. Martin and J. Morrow
THE EFFECT OF STRAIN RATE AND HEAT TREATMENT ON THE TENSILE PROPERTIES OF EXTRUDED BERYLLIUM RODS BETWEEN 25 AND 600°C. Less-Common Metals, Journal, v. 3: 62-88 (February 1961)

Fisher, John G.
NEW ALUMINUM ALLOY SOLVES WELD HEAT-TREAT PROBLEM. Space Aeronautics, v. 36: 87-94 (October 1961)

Kuhn, Joseph B.
HOW TO HEAT TREAT BERYLLIUM COPPER. Metal Progress, v. 81: 87-91 (June 1962)
With adequate furnace facilities and strict adherence to procedures, this versatile alloy can be heat treated in the shop with a minimum of difficulty.

Lubeshkin, V. A., and V. P. Andronov
FLAKES AND BUBBLES IN METALLIC SEMIFINISHED PRODUCTS. Metallovedenie i Termicheskaya Obrabotka Metallov, no. 5: 36-38 (1962) (Russian)
Formation of bubbles in beryllium bronze strip during annealing in an ammonia medium as caused by microscopic flakes. Study of the relationship between thickness of the strip and flake distribution, with determination of bubble and flake concentration by breaking tests.

Paprocki, Stan J. and Ronald F. Dickerson
REACTOR-MATERIALS PROPERTIES. Nucleonics, v. 18: 154-161 (November 1960)

Poulsen, S. C.
SPRING STRIP PREPARATION AND SPRING MANUFACTURE. Machinery (London), v. 98: 947-951 (April 1961)

Sharples, J. T.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 314-317 (Oct. 1961)

Sharples, J. T.
ELECTRIC HEATING FOR NONFERROUS METALS. Metal Industry, v. 99: 361-364 (Nov. 1961)

Smith, E. M.
UNIQUE SALT BATH AIDS HEAT TREATMENT OF STRIP. Metal Progress, v. 81: 83-84 (Mar. 1962)

Furnace with long, shallow troughs which are supplied with molten salt from a small bath. Rapid pumping and close temperature control enable operators to heat treat Be-Cu, phospher bronze and precipitation-hardening stainless steel to the desired mechanical properties.

Somigli, G.
HEAT TREATMENT OF CAST IRON. Metallurgia Italiana, v. 53: 399-342 (Aug. 1961) (Italian)

Heat treatment below the critical point (stress relieving and precipitation hardening) and above the critical point (softening). Extension of the concepts of hardening critical speed and of T-T-T diagrams to cast iron is explained as well as martensitic surface hardening (flame and induction hardening), marquenching and austempering with or without subsequent tempering. Nitriding, sulphurizing, case hardening and bluing.

Thomson, R.
HOT HARDNESS TESTING APPLIED TO THE AGEING AND HEAT TREATMENT OF BERYLLIUM. Journal of Less-Common Metals, v. 3: 170-178 (Apr. 1961)

Industrial Heating, v. 27: Nov. 1960, p. 2503-2504, 2506, 2508, 2510, 2512.
VACUUM AND CONTROLLED ATMOSPHERE HEAT TREATMENTS SPECIALIZED AT METALLURGICAL CONSULTANTS, Inc.

Brazing in all atmospheres, bright annealing, nitriding, vacuum outgassing, aging, and atmosphere quenching of aircraft, missile, atomic and electronic components.

Journal du Four Electrique, Jan. 1962, p. 21-23
HEAT TREATMENT IN VACUUM IN AN ELECTRIC FURNACE. (French)

Heat treatment at 300-2500°C of Ti, Ta, Zr, U, W, Mo, Cb, Be, stainless and high speed steel and Cu-Be alloy nuclear and aircraft components in electric furnaces containing Mo, Ta and W resistors and Ni-Cr refractory alloy. Illustrations of furnace design and construction.

Missiles and Rockets, v. 10: Jan. 8, 1962, p. 24
PROCESS EXTRUDES SMOOTH BERYLLIUM.

AD-258089

Armour Research Foundation, Chicago, Ill.
DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES. Frank A. Crossley.

Ag-Al matrixes are tested in uniaxial compression to determine their composition and optimum heat treatment conditions. The reduction ratio is measured for a compact canned in Cu and extruded at 500°C.

CRGM-1041

Atomic Energy of Canada Ltd., Chalk River, Ont.
THE BEHAVIOUR OF HYDROGEN IN BERYLLIUM. C. E. Ells and W. Evans. Aug. 1961 11p

LMSD-288140

Lockheed Aircraft Corp., Sunnyvale, California
GENERAL RESEARCH IN MATERIALS AND PROPULSION METALLURGY AND CHEMISTRY. V. 2. Jan. 1959-Jan. 1960 244p

NMI-4377 (Suppl.)

Nuclear Metals, Inc., Concord, Mass.
SPHEROIDIZATION HEAT TREATMENT AND RE-EVALUATION OF ZIRCALOY-CLAD U-2 w/o Zr ALLOY TUBE NO. 28, EXTRUSION NO. 18388. D. F. Kaufman, R. G. Jenkins, and W. B. Tuffin. July 29, 1960 38p (Contract AT(30-1)-1565, Sponsor Agreement No. S-31)

The supplementary heat-treatment and re-evaluation of the Zircaloy-clad U-2 wt.% Zr alloy tube No. 28 are described. The previous processing of this tube included both a diffusion anneal and an autoclave acceptance test. As a part of a program for preparing irradiation specimen fuel tubes having cores with radically different metallurgical structures, tube 28 was heat-treated again, reprocessed through another corrosion test, and shipped.

ORNL-3124

Oak Ridge National Lab., Tenn.
INOR-8-GRAPHITE-FUSED SALT COMPATIBILITY TEST. R. C. Schulze and W. H. Cook June 15, 1961.

PB 161920

Manufacturing Laboratories, Inc. (Wright Air Development Division)
RESEARCH AND DEVELOPMENT ON THE EFFECTS OF HIGH PRESSURE AND TEMPERATURE ON VARIOUS ELEMENTS AND BINARY ALLOYS. J. S. Harvey.

"...The precipitation hardening process in both Al-Cu and Cu-Be alloys is significantly restrained..."

SCR-306

Sandia Corp., Albuquerque, N. Mex. and Stevens Inst. of Tech., Hoboken, N. J. Powder Metallurgy Lab.
DEVELOPMENT OF MILITARY COMPONENTS FROM BERYLLIUM BY SLIP CASTING AND POWDER METALLURGY TECHNIQUES. FINAL REPORT, SEPTEMBER 1959-SEPTEMBER 1960. Dec. 1961 74p (Contract (AT(29-1)-789)

SECTION V. BERYLLIUM METALLURGY

PART I. WELDING, JOINING AND ASSEMBLING

Anderson, Gerald V.
ELECTRON-BEAM WELDING JOINS PARTS FOR MACH 3^+ AIRCRAFT. SAE Journal, v. 70: 67-69 (May 1962)
Joining of steel, Ti and refractory alloys by arc-seam welding and electron beam welding for aircraft components. Data on vapor deposition and etching by electron beam process.

Bangs, Scholer
HUGHES AIRCRAFT GETS READY FOR ULTRASONIC WELDING. Welding Design & Fabrication, v. 35: 42-43 (Mar. 1962)
Ultrasonic welding of Dumet to Ni and to Cu; Ni to Cu; Au to Cu; yellow brass to beryllium copper and to Cu; beryllium copper to Cu; and 0.003 in. 300 stainless to 2024 Al.

Bennett, W. D.
RESEARCH IN BERYLLIUM. Canadian Metalworking, v. 24: 29-31 (July 1961)

Bertossa, Robert C., J. A. Hoffman, G. R. Baxter and B. R. Cottrell
A NEW TECHNIQUE FOR BONDING BERYLLIUM COPPER. Digest from "DIFFUSION BONDING OF BERYLLIUM-COPPER FOR ULTRA-HIGH STRENGTH JOINTS". Paper presented at the 43rd Annual AWS Meeting, Apr. 1962, Cleveland. Metal Progress, v. 81: 134, 136, 138, 140 (May 1962)
To diffusion-bond beryllium copper, a thin layer of Ag-Cu-In alloy is sandwiched between fayed, cleaned surfaces. Light pressures at 1475°F. produce bond strengths of over 100,000 psi.

Blair, R. W., D. L. Johnson and J. P. Morley
METAL BELLOWS SEALS. Lubrication Engineering, v. 17: 470-475 (Oct. 1961)

Bland, Jay
WELDING OR BRAZING DISSIMILAR METALS. Product Engineering, v. 31: 46-49 (Dec. 1960)
Techniques used to secure integral joints in the welding or brazing of dissimilar metals including stainless steel, Inconel, Zircaloy and carbon steel. Mechanical and thermal properties of various weld combinations. Stress relief heat treatment is used to reduce weld distortion.

Bodnar, M. J.
ADHESIVES FOR ORDNANCE. Ordnance, 954-955 (May-June 1960)
Epoxies, epoxy-phenolics, nitrile-phenolics and vinyl-phenolics are used to obtain high-strength bonding of missile components. Bonding tests are performed on steel, Al, Cu, Cd, Zn, Be, Nb, Ag, Mo, Re, Ta, W, U238 and Zr. Data are given on adhesive bonding of high explosives to themselves and to other adherents.

Cannizzo, Gregory
ELECTRON BEAM: SPACE AGE WELDING PROCESS. Welding Engineer, v. 47: 35-39 (Feb. 1962)

Review of physical principles and technological parameters of electron beam welding with particular reference to effect of heat generated by electrons on fusion characteristics of the weld zone. Survey of application in fabrication of refractory metals, reactive metals, stainless steel, Al and other metals for use in spacecraft, electronics equipment and nuclear reactors. Review of electron apparatus and ancillary vacuum equipment design, costs and applicability to production scale operations.

Chyle, J. J.
NEW WELDING PROCESSES. Technica, v. 10: 401-406 (Mar. 1961) (German)
Review of special welding techniques such as thermocompression welding (wires to semiconductors), diffusion welding (Au-plated Be-Cu alloy to Cu-plated monel), electroslag welding of very thick steel and iron plates, electron welding of high melting metals (W, Mo, Be, Ta, Zr, Hg), welding by ionized gases at 2800-16500°C., and soldering of sandwich constructions.

Cline, C. L.
BRAZING BERYLLIUM FOR AEROSPACE APPLICATIONS. American Welding Society, 43rd Annual Meeting, Apr. 1962, Technical Abstract.
Research on technique and materials including 6Al-4V Ti alloy and 303 stainless steel, using filler alloys of Ag, Li, Cu, Al, Mn, Zn, Cd and Ni. Tensile testing from room temperature to 1060°F. indicates the highest ultimate tensile strength is achieved utilizing an Ag-Cu-Li filler.

Fischer, G.
ULTRASONIC WELDING MACHINES. Mecanique et Electricite, v. 46: 29-38 (Jan. 1962) (French)
Construction and operating principles of the machines. Effect of ultrasonic welding without melting under specified conditions of time, compressive force, vibration amplitude, frequency and surface condition of metal on the crystal structure, He permeability and rupture resistance of the welds and formation of intermetallic compounds in Al, Ag, Be, Cu, brass, Sn, Fe, steel, Ge, Mg, Mo, Ni, Au, Pd, Pt, Si, Ta, Ti, W and Zr electronic and aeronautical components.

Fisher, John G.
NEW ALUMINUM ALLOY SOLVES WELD HEAT-TREAT PROBLEM. Space Aeronautics, v. 36: 87-94 (Oct. 1961)
Comparison of welding tests of Tens 50, an Al-Mg-Si alloy modified by Na and Be, with other weld-filler materials for aerospace systems. Design of assemblies using the alloy and methods of welding and heat treatment.

Fishlock, David
PRECIOUS METAL BRAZING MAKES BETTER MAGNETRONS. Metalworking Production, v. 105: 49-53 (Nov. 1961)
Composition, applications and physical and thermal properties of precious metal brazing alloys used in the production of brazed assemblies for magnetrons. Techniques and equipment used in brazing refractory metal components. Design, size and operation of the completed magnetron.

Hessler, B. H.
FABRICATION OF BERYLLIUM SHEET. Light Metal Age, v. 19: 10-12 (February 1961)

Hoffman, J. A., G. R. Baxter, R. C. Bertossa and B. R. Cottrell
DIFFUSION BONDING BERYLLIUM COPPER FOR ULTRA HIGH-STRENGTH JOINTS. Welding Journal, v. 41: 160s-166s (April 1962)
Effects of filler metal (Ag, Cu, In and Au), bonding temperature, time and atmosphere, and post bonding heat treatment on the hardness, microstructure, grain growth and tensile strength.

Ikuye, K. K. and Gerald R. Grow
BRAZING BERYLLIUM OXIDE TO PYROLYTIC GRAPHITE. American Welding Society, 43rd Annual Meeting, April 1962, Technical Abstract.
Development of techniques and materials for producing joints capable of operation at temperatures to 2500°F at low stress levels. Wettability studies conducted utilizing alloys of Zr, Si, Cr, Ti, Pd, Ce, Gd, V, Fe and Ni.

Irving, R. R.
WELDING MEETS CHALLENGE OF SPACE AGE METALS. Iron Age, v. 187: 99-106 (April 1961)
Electron-beam, inert-gas shielded and vacuum chamber techniques for welding W, Ta, Mo, Cb, Zr, Ti and Be with attention to effects of purity of base metal and welding environment on weld strength and ductility.

Irving, R. R.
WELDING NEW METHODS FOR NEW METALS. Iron Age, v. 189: 89-96 (March 1962)
Review of research covering application of the electron beam, plasma and laser processes to be welded of high strength materials. Possibility of automatic control of weld performance and inspection.

Jahnle, Herbert A.
RESISTANCE SPOT WELDING BERYLLIUM. Welding Journal, v. 41: 331-336 (April 1962)
Development of welding procedures, including pre and post-heating for relief of residual stresses and reduction of electrode sticking by improved surface finish. Influence of processes, design and impurities on mechanical properties and microstructure.

Jahnle, H. A.
RESISTANCE SPOT WELDING BERYLLIUM SHEET. American Welding Society, 43rd Annual Meeting, April 1962, Technical Abstract.
Investigation into crack initiation during welding discloses impurities, temperature and fracture plane alignment as causative factors. Specimens subjected to tensile testing from room temperature to 800°F and metallographic examination.

Jones, Alfred G.
MACHINING FOR MACH 3^+ STRUCTURES. Space/Aeronautics, v. 34: 97-99, 101, 103 (November 1960)

Lowy, Mortimer and Robert I. Jaffee
DEVELOPMENT OF LOW-COST, FORMABLE, ALL-METAL SANDWICH PANELS WITH CORRUGATED CORES. Aerospace Engineering, v. 20: 14-15, 28-30 (Nov. 1961)
Fabrication of sandwich structures from A-55 Ti, 15-7 Mo Stainless steel and Al by pressure welding in a hot rolling operation using a Cu matrix to prevent buckling or wrinkling during forming. Applicability of the process to Rene 41, Be, Mo and 6Al-4V Ti.

MacPherson, B. M. and W. W. Beaver
HOW TO FUSION WELD BERYLLIUM. Welding Journal, v. 41: 327-330 (Apr. 1962)
Gas tungsten arc processes using Al-Si, Be-Si and Ag filler metals for welding Be sheets: Standardized procedures are enumerated for welding Be by the tungsten arc method. Comparison of Be with Mg, Al, stainless steel and Ti with reference to mechanical and physical properties.

Nadler, Max A. and George Epstein
BONDED COMPONENTS IN ROCKET MOTORS. Aerospace Engineering, v. 21: 70-71, 86, 88-89 (May 1962)
Thin strips of work hardened steel, Ti and Be alloys are bonded by epoxy resin based adhesives to produce laminates having high strength to weight ratios for service in pressure vessels, rocket components and rifle liners.

Maloof, S. R. and J. B. Cohen
BRAZING OF BERYLLIUM FOR HIGH TEMPERATURE SERVICE. Welding Journal, v. 40: 118S-122s. (March 1961)
Procedure for Ag brazing of Be to produce strong joints for use up to 1450°F. Data are given for design and preparation of braze materials and results of wettability tests. Effect of brazing time and joint structure on the strength of butt-brazed joints.

Mitchell, W. R., J. A. Mullendore and S. R. Maloof
ZONE PURIFICATION OF BERYLLIUM. Metallurgical Society of AIME, Transactions, v. 221: 824-826 (Aug. 1961)

Monroe, R. E. and K. J. Miller.
ELECTRON BEAM WELDING. Canadian Machinery and Metalworking, v. 73: no 8, 77-80 (Aug. 1962)
Evaluation of electron beam welding for joining 300 series stainless, 4130, 4340, Ti 6Al-4V, Ti 8Al-1V, Ti 13V-11Cr-3Al, Cb, Ta, Mo, W, other super-alloys and Al alloys.

Newburn, J. M.
FUSION WELDING OF THE LESS COMMON METALS. Paper from "AUSTRALIAN ATOMIC ENERGY SYMPOSIUM". Melbourne University Press, Melbourne, Australia. 1958, p. 216-220.
Review of the literature on the fusion welding of Be, Hf, Nb, Ta, Th, Ti, U, V and Zr. Direct current inert gas-shielded arc process is the preferred welding procedure.

Peteghem, A. Van
MODERN INTERPRETATION OF SEVERAL BRAZING PHENOMENA. Revue de la Soudure-Lastijdschrift, v. 17: no. 2, 94-109 (1961) (French)

Formation of oxide films, oxygen diffusion and corrosive effects in the brazing of Al, Cd, Sn, Pb, Zn, Ni, Cu, Si, Mn, W, Fe, Cr, Be, Ag, Ti, V, Mo, Sb alloy steel and cast iron at 600-1100°C. Effects of time, temperature, distance, gas concentration, polarization, voltage, hydrogen content and alloy homogeneity.

Pumphrey, W. I.
DEVELOPMENTS IN ARC WELDING. Metallurgia, v. 65: 159-163 (Apr. 1962)

Review of process technology including metal arc, gas-shielded arc, submerged-arc, electroslag and arc-plasma welding, with application to particular metals including mild, low-alloy and high-alloy steels, cast irons, Cu, Al, Ta, Zr, Ti, Mo, W, Hf and Be metals and alloys.

Reeder, Ray K. Jr., and Roger A. Long
NEW APPROACH TO CERAMIC PACKAGING. (Abstract of paper no. 7-L-62 presented before American Ceramic Society) American Ceramic Society, Bulletin, v. 41: 233 (Apr. 1962)

Rhys, D. W. and W. Betteridge
BRAZING FOR ELEVATED TEMPERATURE SERVICE. Metal Industry, v. 101: no. 2, 27-30 (July 1962)

Conditions and requirements for brazing Cu, cast Fe, mild and stainless steel refractory metals, precious metals and ceramics; consideration of brazing temperatures and atmospheres and preliminary cleaning and plating.

Roberts, J. P.
GASTIGHTNESS OF CERAMICS. Paper from "Seventh International Ceramic Congress, Transactions". British Ceramic Society, London, 405-410 (1960)

Review of applications of dense impermeable ceramics including use in vacuum seals, insulators and chemical and nuclear equipment. Problems of attaining impermeability to gas are summarized and analyzed in terms of various mechanisms by which gas may move in solids. Data are given for leak rates of sintered Al_2O_3 tubes of varying porosity in air at different temperatures and pressures.

Ross, J. W.
WHAT WILL WELDING'S NEXT TEN YEARS BRING? Canadian Machinery and Metalworking, v. 73: no. 8, 84-86, 114, 116 (Aug. 1962)

Outline of application and description of procedures for short arc, electron beam, arc spot, electroslag, electrogas, high frequency, foil seam, ultrasonic friction, explosive and plasma arc welding along with high temperature brazing and diffusion bonding.

Russel, D. V.
DEVELOPMENTS IN ELECTRON BEAM WELDING MACHINES. Sheet Metal Industries, v. 39: 495-499 (July 1962)

Description of a low-voltage (30 kV) electron beam gun in terms of size, beam power, mobility and control means for velocity and position. Welds are shown for thick Al plate and a Be-Cu diaphragm.

Sharples, J. T.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 314-317 (Oct. 1961)

Sharples, J. T.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 361-364 (Nov. 1961)

Sharples, J. T.
ELECTRIC HEATING FOR NON-FERROUS METALS. Metal Industry, v. 99: 383-384 (Nov. 1961)

Slaughter, G. M.
JOINING REFRACTORY METALS IS TRICKY BUSINESS. SAE Journal, 52-55 (May 1961)

Welding and brazing of Be to refractory metals W, Ta, Mo, Cb, Fe and Ni. A study is made on the influence of impurities on transition temperature for recrystallized metals. Intermetallic formation, weld porosity and thermal expansion behavior are discussed.

Tatman, M. E.
PROCESSING BERYLLIUM. Aircraft Production, v. 23: 466-470 (Dec. 1961)

Weismantel, E. E. and C. F. Cole
WELDING PRACTICES FOR THE BERYLLIUM-COPPER ALLOY SYSTEM. American Welding Society, 43rd Annual Meeting, Apr. 1962, Technical Abstract.

Effects of Be additions on weldability, tensile strength, ductility, conductivity and distortion at low temperature, as determined by a program involving Tig, Mig and submerged-arc welding, joint preparation and post-weld thermal treatment. Results indicate that properties approaching 90% of base metal strength can be attained.

White, S. S., H. J. Lander, W. T. Hess and R. Bakish
A STUDY OF ELECTRON BEAM WELDING. Welding Journal, v. 41: 279s-288s (June 1962)

Electron beam welding of H-11 steel, Be, Ti, 6Al-4V, 4Al-3Mo-1V, 2.5Al-16V, 5Al-2.5Sn and 13.5V-11Cr-3Al Ti alloys; relationship of the fusion zone width and interstitial gas content to the ultimate tensile strength, grain size, impact resistance and porosity.

White, S. S., H. J. Lander, W. T. Hess and R. Bakish
A STUDY OF ELECTRON BEAM WELDING. PT. 2. Welding Journal, v. 41: 329s-336s (July 1962)

Effects of weld width, temperature, atmosphere and heat flow on melting point, ultimate tensile strength and impact strength. Materials investigated included H-11 steel, 301 stainless steel, Be, Ti, Mo and W.

Whitson, Everette M.
VACUUM BRAZING OF STAINLESS STEEL TO BERYLLIUM. Metal Progress, v 82: 93-95 (July 1962)

A new technique of brazing stainless steel to Be results in vacuum-tight joints twice as strong as those previously obtained. Pretreatment of the component surfaces as well as the brazing operation itself, is done in a furnace capable of maintaining a vacuum of 0.1 micron.

Automation, v. 9: May 1962, p. 80
AUTOMATIC MACHINE WELDS CONTACTS TO VARIETY OF PARTS.
Electrical contacts, stamped from normal-backed Ag tape, are joined to steel, brass, Be, Cu and Ag by a magnetic force bench welder.

Canadian Chemical Processing, v. 45: 69-76 (Feb. 1961)
NEW MATERIALS FOR PROCESS UNITS.

Cuivre Laitons Alliages, no. 63, p. 13-16 (Sept-Oct. 1961)
WELDING AND BRAZING OF COPPER AND ITS ALLOYS. (French)
Resistance, arc and oxy-acetylene welding and brazing with Ag, Ni, Sn-Zn, Al-Si, Cu-Au, Tn, Cu-Ni and Cu at 200-1100°C. of Cu alloy electrical, electronic and machine components with data given on corrosion, wear, friction and electrical resistance and brittleness.

Engineering Materials and Design, v. 5: 28-29 (Jan. 1962)
RECENT DESIGN DATA ON BERYLLIUM.

Engineering Materials and Design, v. 5: 268-273 (Apr. 1962)
SURVEY OF INDUSTRIAL FASTENERS.

Light Metal Age, v. 19: p. 18 (June 1961)
FABRICATION OF BERYLLIUM AND TITANIUM FOR THE SPACE CAPSULE.

Machine Moderne, v. 55: 49-50 (November 1961)
ELECTRON BOMBARDMENT. (French)
Effects of welding, melting, heating and evaporation, using electron bombardment in a vacuum at varying temperatures, on weld depth and the purity and cleanliness of bars and ingots of powdered uranium carbide, Si, Mo, Ta, Al, W, refractory metals and metal carbides and oxides.

Machinery (London), v. 100: 323-330 (Feb. 1962)
SCIAKY ELECTRON BEAM WELDING EQUIPMENT.
Characteristics of electron beam welding gun and auxiliary equipment. Procedures for welding stainless steel plate up to 1 in. in thickness, Al bars, refractory metals, dissimilar metals.

Materials in Design Engineering, v. 53: p. 19, 203 (May 1961)
METAL HONEYCOMB COSTS CUT.
Development of a roll welding process in which plates of corrugated metal cores are hot rolled and pressure welded simultaneously to cover sheets.

Metal Industry, v. 100: 102-104 (Feb. 1962)
FORMABLE SANDWICH PANELS.

Metalworking Production, v. 105: 19 (Jan. 1961)
HOW TO JOIN BERYLLIUM.
Fusion welding, diffusion welding, braze-welding and furnace brazing techniques for Be.

Reactor Core Materials, v. 3: 51-60 (Aug. 1960)
SPECIAL FABRICATION TECHNIQUES.

Reactor Core Materials, v. 4: 17-27 (May 1961)
NSF MODERATOR MATERIALS.
"Review of recent work on graphite, Be metal..."

Reactor Core Materials, v. 4: 52-68 (Aug. 1961)
SPECIAL FABRICATION TECHNIQUES.

Ryan Reporter, v. 23: 35-37 (May-June 1962)
Joining of refractory metals, cast, wrought and extruded Al and its alloys, carbon steels and stainless steels by dip brazing at 1000-1100°F. short arc and molectrobond welding techniques; brazability and fabricability determination.

Steel, v. 149: 121-122 (July 1961)
WELDING KEEPS UP WITH UNCOMMON METALS.
Electron beam, ultrasonic and arc welding; diffusion bonding and brazing as methods for joining W, Cb, Mo, Ti, Zr and Be.

Steel, v. 149: 81 (Aug. 1961)
SINGLE PURPOSE WELDER DOES SEVEN JOBS.
Welding of steel, brass, Be-Cu and Ag to produce electrical contacts using a magnetic force bench welder automated by handling, blanking and forming devices.

Steel, v. 150: 117-120 (Apr. 1962)
DIFFUSION BONDING.
Joining of Al alloys, Ti alloys, Be-Cu, Cu, steel, stainless steel, W, Be, graphite and Monel by atom transfer to form a high strength bond. Effects of time, temperature, pressure, surface roughness and crystal lattice.

Union Carbide Metals Review, v. 4: 10-12, Fall 1961
MERCURY METALS--"A-OK".
Fusion, seam and spot welding of Ti sheet and rings, 5Al-2.5Sn Ti alloy, Haynes R 41, Be shingles and billets and stainless steel-encased thermal insulation in the fabrication of space capsules resistant to high take-off and re-entry pressures of 20 G's and temperatures of 11,000°F.

Welding and Metal Fabrication, v. 29: 406-408 (Oct. 1961)
FLASH-BUTT WELDING WHEEL RIMS.
Cutting, straightening, bending, flash-butt welding, expanding, recompressing and testing operations for the production of wheel rims for trucks from profiled steel strip. Design and welding cycle of the rim-welding machine.

Welding Journal, v. 40: 349-358 (Apr. 1961)
ULTRASONIC WELDING ENGINEERING, MANUFACTURING AND QUALITY CONTROL PROBLEMS.
Principles of ultrasonic welding and applications in joining dissimiliar metals, alloys and other materials. Data are given for cooling, clamping force and welding, tip requirements; vibration problems and their control; and ultrasonic welding schedules.

Western Metalworking, v. 20: 27-29 (March 1962)
ELECTRON BEAM JOINS 35 METALS IN B-70 PROGRAM.
Depth to width ratio, weld shrinkage, energy density and distortion in electron beam welding of steels, refractory alloys, Ti, Cb, Mo, Mg and Al alloys.

AD-257663
Aerospace Technical Intelligence Center, Wright-Patterson Air Force Base, Ohio
SOLDERING OF METALS (SELECTED ARTICLES). N. F. Lashko and S. V. Lashko-Avakyan
Soldering and brazing of stainless chromium steels, toolsteels and hard alloys, Mo, W, Ti, Zr and Be.

AD-269349
Brush Beryllium Co., Cleveland, Ohio
FUSION WELDING OF BERYLLIUM. FINAL REPORT, MAY 1, 1959-AUGUST 31, 1960, ON METALLIC MATERIALS. B. M. MacPherson and W. W. Beaver. April 1961. 63p. (WADD TR 60-917) (Contract AF 33 (616)6413, Proj. 7351)
Standard conditions for fusion welding of Be. Studies of the effects of post-heat treatment and fixturing on fusion welds, along with studies of multiple pass and fillet welding of Be. Effects of residual impurities on the weldability relative to the Be filler wire development phase. Coating of drawn Be welding wire with Cu, Ag, Au, Ni, Fe, Co, Sn, Cr, Zn and Cd.

ASD-TR-61-322 (p. 661-76)
Aeronautical Systems Div., Wright-Patterson AFB, Ohio
WELDING AND BRAZING SPACE AGE METALS. R. Bowman.
Fabrication of aircraft and missile components by welding and brazing of Be, Ti, high strength steel, stainless steel, heat resistant alloys, Ni base alloys and refractory metals and alloys.

ASM-Paper-61-AV-13
American Society of Metals
ADVANCED FABRICATION TECHNIQUES. R. Garcey, J. Glyman, and E. Green. 1961. 19p.

ASM-Paper-61-AV-61
American Society of Metals
NEW JOINING PROCESSES FOR UNCOMMON MATERIALS. R. E. Monroe. 1961. 7p.
Review of electron beam, ultrasonic, plasmajet and explosive welding, inert gas-shielded electrode welding, diffusion bonding and brazing techniques for uncommon materials such as Cb, W, Ti and Zr.

BAW-1100
Babcock and Wilcox Co. Research Center, Alliance, Ohio
LIQUID METAL FUEL REACTOR EXPERIMENT. INVESTIGATION OF BERYLLIUM WELDING TECHNIQUES FOR REACTOR PORT THIMBLE JOINTS. Paul C. Thys. Changed from OFFICIAL USE ONLY October 18, 1960. April 1960. 24p. (Contract AT(30-1)-1940)
To measure the neutron level of the Liquid Metal Fuel Reactor (LMFR), a detector must be placed in a thimble and inserted into the graphite core assembly. The approximate dimensions of the thimble

are: length, 11 ft; diameter, 3 in.; wall thickness, 1/8 in. One end will be closed, the other joined to the vessel wall by a flange. The thimble was to be made of beryllium because (1) it would not necessitate an addition of fuel to maintain criticality when inserted into the core assembly, and (2) it has good corrosion resistance to molten bismuth. Beryllium tubing is not available in 11-ft lengths; therefore, two or more lengths must be joined. Since previous beryllium-to-beryllium welding has been unsatisfactory, a method of joining the lengths had to be developed. An end-cap joint was successfully welded using tungsten inert-gas procedures. Examinations showed no leakage or defects. Excellent facilities for handling beryllium and beryllium compounds have been provided, and a safe operating procedure based on AEC recommendations has been established.

BMI-1489 (Rev.)
Battelle Memorial Inst., Columbus, Ohio
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING DECEMBER, 1960. Russell W. Dayton and Clyde R. Tipton, Jr. January 1, 1961. 79p. (Contract W-7405-eng-92)

Research areas include: gas-pressure bonding of beryllium-clad fuel elements.

BMI-1545
Battelle Memorial Institute, Columbus, Ohio
PRELIMINARY STUDIES OF BONDING OF BERYLLIUM-CLAD UO_2 FUEL ELEMENTS. S. Paprocki. September 1961. 20p.

The gas pressure process appears to be particularly suited for joining Be. The only deformation involved in the process is that necessary to bring mating surfaces into intimate contact. As a result cracking and the amount of preferred orientation in the components being joined can be minimized or prevented.

DMIC-Report-159
Defense Metals Information Center, Battelle Memorial Institute
GAS-PRESSURE BONDING. S. J. Paprocki, E. S. Hodge, and P. J. Gripshover. September 1961. 42p.

The gas-pressure-bonding process is used for joining, cladding and densifying Al, Be, Mo, Cb, V, Ta, W, Rh, Zr, Cr, Fe, Al, (304, 316, 347, 410) stainless steels and ceramic materials (UO_2, BeO, MgO, UN, UC). The solid state bonding process is conducted in a hot wall high pressure autoclave at 300-2700°F with gas pressures of 5000-30,000 psi.

DMIC-Report-165
Defense Metals Information Center, Battelle Memorial Institute
METHODS OF EVALUATING WELDED JOINTS. M. D. Randall, R. E. Monroe and P. J. Rieppel. December 1961. 74p.

Survey of methods used to evaluate weld joints quality. Review of welding processes used, material and thickness involved, with emphasis on tension, shear, bend, impact, fatigue, stress rupture, creep, crack susceptibility and propagation and weld soundness testing techniques.

NMI-9502
Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. Quarterly

Progress Report for the Period April 1, 1960 to June 30, 1960. S. H. Gelles. July 26, 1960, 25p (Contract AF33(616)-7065)

NMI-9509

Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period October 1, 1960-December 31, 1960. S. H. Gelles. Mar. 1, 1961, 114p (Contract AF33(616)-7065)

NMI-9515

Nuclear Metals Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report to Aeronautical Systems Div. for the Period Apr. 1, 1961 through June 30, 1961. S. H. Gelles. Aug. 11, 1961, 18p. (Contract AF33(616)-7065)

Study of resistance welding and brazing for producing crack and void free welds in Be sheets. Analysis of mechanical properties as influenced by an observed second phase in the distilled sheets.

NP-7901

Brush Beryllium Co., Cleveland, Ohio
FUSION WELDING OF BERYLLIUM. Progress Report No. 1, May 1 to July 31, 1959. B. M. MacPherson and W. W. Beaver. Aug. 15, 1959, 19p (Project No. 7351) (Contract AF33(616)-6413)

The background for the work on fusion welding of beryllium is reviewed. The initial metallurgical examination of fused welds made with filler rods of QMV virgin beryllium is evaluated.

NP-8626

Brush Beryllium Co., Cleveland, Ohio
FUSION WELDING OF BERYLLIUM. Technical Report No. 161. Progress Report No. 2, August 1 to October 31, 1959. B. M. MacPherson and W. W. Beaver. Nov. 1959, 21p (Project No. 7351) (Contract AF33(616)-6413)

Standard welding conditions for the fusion welding of beryllium, based on 1/8-inch QMV beryllium sheet, are reported. Weld tests were made using drawn beryllium wire coated with copper, silver, gold, nickel, iron, cobalt, tin, and chromium. In addition to the grain-growth problem, excess welding amperage was found to be the major cause of weld porosity and cracking.

NP-9312

Brush Beryllium Co., Cleveland, Ohio
FUSION WELDING OF BERYLLIUM. Progress Report No. 3, Nov. 1, 1959-January 31, 1960. Technical Report No. 167. B. M. MacPherson and W. W. Beaver. Feb. 1960, 22p (Project No. 7351) (Contract AF 33(616)-6413)

The effects of coating drawn beryllium wire with Cu, Ag, Au, Ni, Fe, Co, Sn, Cr, Zn, and Cd on the fusion weld properties of beryllium are reported. Since a post-heat treatment of beryllium fusion welds is beneficial to the physical properties, initial evaluations of various heat treatments have been made. Metallurgical studies on 1/8- and 1/4-in.-thick QMV beryllium welded sheets are in process for butt and fillet-welded "T" joints. The welding of 1/4-in.-thick Be sheets served as an excellent medium for examining the function of

fixture materials on the weldability of this metal. With the successful welding of 1/4-in.-thick beryllium in one pass, initial work on making multiple-pass fusion welds in thicker sections of beryllium was performed.

NP-9481

Brush Beryllium Co., Cleveland, Ohio
FUSION WELDING OF BERYLLIUM. Progress Report No. 4, Feb. 1, 1960 to April 30, 1960. Technical Report No. 181-220. Bruce M. MacPherson and W. W. Beaver. Aug. 15, 1960, 16p (Project No. 7351) (Contract AF33(616)-6413)

Sound welds were made on 0.125- and 0.250-in.-thick virgin and blend beryllium sheet by the tungsten-inert gas process. Attempts to fusion weld 1-in.-thick plate by the multipass technique were unsuccessful. Results of post-heat-treatment studies revealed that a longer time at temperature does not affect the fusion weld and that only the temperature at which the weld is post-heat-treated affects the welding properties.

NP-tr-624

SOLDERING OF BERYLLIUM. p. 50-57 (Translation)

Solderability of Be is affected by surface oxide formation. Effect of tinning and soldering with an Ag-Cu eutectic or weld-brazing with Al alloys under vacuum in an inert atmosphere.

Patents - British 870, 780

BERYLLIUM BRAZING. Denzil Malcolm Atkinson. (Associated Electrical Industries, Ltd.) June 21, 1961.

Brazing of Be to dissimilar metals using an Ag-Cu-Pd solder, the assembly being then heated in a vacuum of high-purity hydrogen to 830-840°C. for 5 min. to cause interdiffusion between the Be and the solder with subsequent cooling to 700°C.

Patents - British 877, 580

IMPROVEMENTS IN OR RELATING TO PRESSURE WELDING OF METALS. Jack Williams and William Munro. (United Kingdom Atomic Energy Authority). Sept. 13, 1961.
Pressure welding of Be tube to a Be end plug at 750-850°C. using a deformable material such as mild steel to transmit pressure and resulting in a more uniform weld. Effect of process on weld uniformity.

Patents - French 1, 250, 220

ASSEMBLING ELEMENTS, PARTICULARLY NUCLEAR FUEL ELEMENTS. (Sylvania Corning Nuclear Corp.) Nov. 28, 1960.

PB-161830

Avco Corp. (Wright Air Development Division).
BERYLLIUM JOINING RAD SPONSORED PROGRAM. J. B. Cohen. Apr. 1960, 45 p.

New brazing techniques for joining Be to itself. A Be 20 at.% Ag brazing alloy yields joint strengths at room temperature of 60% (30,000 psi) of that of the base metal. In temperature ranging from 700-1450°F. the joint strength is 80% that of the base metal.

PB-161831

Avco Corp. (Wright Air Development Division)
BERYLLIUM JOINING WADS SPONSORED PROGRAM. E. M. Passmore.

Apr. 1960, 127p.

Joining of Be plates and rods by braze welding, fusion welding and pressure welding investigated to develop improved methods for applications at both room and elevated temperatures. Braze welding with Ag filler metal and pressure welding without filler are the most promising techniques for joining Be.

PB-161863

Feltman Research Laboratories

ADHESIVE BONDING OF METALS FOR ADVANCED ORDNANCE APPLICATIONS. John J. Veliky. September 1960. 21p.

The practicability of bonding unusual metals such as Be, Cr, Au, Ag and U^{238} with two thermosetting adhesives, a polyester and a polysulphide-modified epoxy are explored. Two additional adhesives, a polyurethane and an epoxy polyamide are used with the uranium because of difficulties encountered in bonding to this material.

SAE-Paper-340E

WELDING AND BRAZING OF REFRACTORY METALS. G. M. Slaughter. 1961, 5p.

Procedures for welding and brazing refractory metals and Be taking into account problems of transition temperature, reactivity with impurities, recrystallization of parent material, porosity in welds and intermetallic formation and thermal expansion differences in brazing.

SAE-Paper-514A

ELECTRON BEAM WELDING TECHNIQUES AS APPLIED TO AERO-SPACE STRUCTURES. Robert Bakish. 1962, 10p.

Review of low, medium and high voltage techniques and equipment for welding Mo, W, Cb, Ta, 301, A-286 and 17-7 PH stainless steel, H-11 toolsteel, Be and Ti alloy aircraft parts. Ultimate tensile strength, grain structure, impact resistance and fusion zone strength are evaluated as functions of temperature, power input and linear welding speed.

TID-14971

Knolls Atomic Power Lab., Schenectady, N. Y.

WELDING OR JOINING OF EXOTIC METALS. Jay Bland. February 1962. 11p. (Contract W-31-109-eng-52)

Summary on the welding of Cb, Be, U, Zircaloy-2, Ti, Mo, Inconel, stainless steel, Cu, Al, carbon steel and Hf.

WADC-TR-59-695 (Pt. 1)

Avco Corp. (Research and Advanced Development Div.) Wilmington, Mass.

BERYLLIUM JOINING RAD SPONSORED PROGRAM, JULY 1958-OCTOBER 1959. Project title: METALLIC METALS. Task title: BERYLLIUM AND BERYLLIUM ALLOYS. J. B. Cohen. January 1960. 45p. (Contract AF 33(616)-5913)

New brazing techniques are described for joining Be to itself. A Be^{20} at. % Ag brazing alloy is shown to yield joint strengths at room temperature of 60% (30,000 psi) of that of the base metal. At 700 to 1450°F the joint strength is 80% that of the base metal. Twenty-four hour exposures at these temperatures did not affect the room temperature

strength. Similar strengths are achieved by brazing with pure Ag, if a continuous interface of Ag in the joint is absent. This is readily accomplished by heat treatment because of the rapid intergranular penetration of Ag into Be. The resulting thick joint is not deleterious, since it is shown that a two phase Ag-Be alloy with a Ag network is ductile. As in the above case, long-time exposure (24 hrs) at temperatures above 1300°F did not affect the room temperature joint strength. Spreading of liquid Ag on Be is not appreciable, probably because of its rapid intergranular penetration.

WADC-TR-59-695(Pt. II)

Avco Corp. (Research and Advanced Development Div.) Wilmington, Mass.
BERYLLIUM JOINING WADC SPONSORED PROGRAM. JUNE 1958-OCTOBER 1959. Project title: METALLIC MATERIALS. Task title: BERYLLIUM AND BERYLLIUM ALLOYS. E.M. Passmore. Jan. 1960, 126p (Contract AF33(616)-5913)

Joining of Be plates and rods by braze welding, fusion welding, and pressure welding was investigated, with the objective of developing improved methods for applications at both room and elevated temperatures. It is concluded that braze welding with silver filler metal and pressure welding without filler offer the most promise as useful joining techniques for Be.

WADD-TR-60-917

Brush Beryllium Co., Cleveland, Ohio
FUSION WELDING OF BERYLLIUM. B. M. MacPherson and W. W. Beaver. Jan. 1961, 63p (Contract AF33(616)-6413)

Fusion welding, post heat treating, fixturing, multiple-pass and fillet welding of Be residual impurities. Coating of the drawn Be welding wire with Cu, Ag, Au, Ni, Fe, Co, Sn, Cr, Zn and Cd. Determination of weld properties and the residual impurity effect on weldability.

SECTION V. BERYLLIUM METALLURGY

PART J. CLEANING, COATING, AND FINISHING

Browning, M. E.
ALLOY PRECIPITATION SYSTEMS AND THEIR APPLICATION IN AVIATION AND SPACE TECHNOLOGY IN THE U. S. A. Metalloberflache, v. 16: 135-141 (May 1962) (German)
Review of electrolytic precipitation, evaporation and plasma spraying of metal alloy coatings for corrosion and scaling protection, as bearing materials and for electronic devices. Evaluation of properties of coatings.

Dingle, J. H. and A. Moore
A RAPID ELECTROLYTIC METHOD FOR THE PREPARATION OF METALLOGRAPHIC SURFACES ON FABRICATED BERYLLIUM. Institute of Metals Journal, v. 90: 270-271 (March 1962)
Fabricated Be is rough polished with silicon carbide paper and electropolished using Mott-Haines electrolyte at room temperature. Examination of specimens for grain size and shape and fracture mode.

Doerr, J. S.
CHEMICALS CONSUMED IN THE MANUFACTURE OF STEEL. U. S. Steel Corp. Technical Paper, Science and Technology, v. 8, no. 1: 5p. (1961)
Survey of applications of chemicals in steel refining, hot forming, finishing and inorganic coating including oxygen, acids, lime, alkalis, oils, coke, aluminum oxide and fluoride, magnesium chloride, titanium and uranium tetrafluoride, artificial cryolite, zirconium chloride and sodium sulphate. Production and consumption data are given for use of electrolytic Mn and minor metals in steelmaking.

DuRose, A. H.
TYPICAL PROCESSING AND OPERATING SEQUENCES. Chapter 4 from ELECTROPLATING ENGINEERING HANDBOOK. 2nd Ed. Reinhold Publishing Corp., New York, 1962, p. 190-211.
Pretreatment techniques in relation to the actual plating process. Cycles are described for a large number of metals and alloys with a bibliography appended for each major class of material.

Epstein, George and Sidney Litvak
BONDING BERYLLIUM. Adhesives Age, v. 5: 22-24 (January 1962)
Lamination of Be to itself and to steel using epoxy-base adhesives with subsequent curing at 350°F. Surface treatment prior to bonding and lap-shear tests of the reinforced bonded specimens. Physical and mechanical properties of Be.

Gore, James K. and James J. Glass
THE PRACTICAL APPLICATION OF STATISTICS TO THE QUALITY CONTROL OF ELECTROPLATED PRODUCTS. Paper from 48th ANNUAL TECHNICAL PROCEEDINGS. American Electroplaters' Society, Inc., Newark, 1961, p. 115-119.

Hessler, B. H.
FABRICATION OF BERYLLIUM SHEET. Light Metal Age, v. 19: 10-12 (February 1961)

Hessler, B. H.
ROLLING OF BERYLLIUM SHEET TAKES SPECIAL TECHNIQUE. Iron Age, v. 186: 136-138 (December 1960)

Hollis, W. S.
WHISKERS – A FABRICATING MEDIUM OF THE FUTURE? Metalworking Production, v. 106: 71-73, 75 (June 1962)

Janssen, J., J. Luck, and R. Torborg
REFLECTANCE OF ANODIZED TITANIUM AND BERYLLIUM. Paper Presented at the Los Angeles Meeting, The Electrochemical Society, no. 169, May 6-10, 1962.
Passive temperature control of space craft as achieved by selection of coatings with the proper thermal radiation properties. The spectral reflectance of anodized Ti and Be is measured from 0.04-22 micron in a vacuum of 10^{-5} mm Hg at temperatures of 100-1300°F, with the effect of anodizing variables on the reflectance for thermal control applications.

Johnson, Alfred L.
SPACECRAFT RADIATORS. Space/Aeronautics, v. 37: 76-82 (January 1962)
Review of metallic, nonmetallic, organic and inorganic coatings including Be, Mg, Al_2O_3, NO, Au, ThO_2, quartz, glass, clay and paint for maintenance of heat balance at 1000-2400°F and for meteoroid protection of spacecraft components. Effects of solar radiation, absorption, convection, conduction and normal emissivity of the coatings as applied to spacecraft components.

Mash, D. R., N. E. Weare and D. L. Walker
PROCESS VARIABLES IN PLASMA-JET SPRAYING. Journal of Metals, v. 13: 473-478 (July 1961)
Review of experimental data with reference to spraying equipment, techniques and materials including ZrO_2, UO_2, TiC, ZrC, TaC, TiN, 4340 and 304 steel, B_4C and W. Substrates sprayed include 304 stainless steel, Al, Zircaloy 2, mild steel and Be.

Mash, Donald R.
PLASMA-ARC SPRAYING OF SPACE-AGE MATERIALS. Western Machinery and Steel World, v. 53: 48-53 (April 1962)
Effect of spraying, melting, welding, cutting, machining, spherodizing, surface hardening, deoxidation, crystal growing and testing of refractory metals, stainless steels, oxide, nitride, silicide, sulphide, carbide, boride, cermet, glass, porcelain, graphite, plastics and silica on mechanical and physical properties and corrosion resistance.

Mash, Donald R.
PLASMA-ARC SPRAYING OF REFRACTORY METALS. Fansteel Metallurgy, 2-3 (June 1962)
Plasma-arc spraying of W, Re, Ta, Mo, Cb, TaC, 304 stainless steel, BeO and ZrO_2 in an Ar atmosphere. Effect of plasma enthalpy, Ar arc gas flow and hydrogen content on density.

Mash, D. R.
PLASMA-ARC SPRAYING OF REFRACTORY METALS. Canadian Machinery and Metalworking, v. 73, no. 8: 81-83 (August 1962)
Applications for plasma-arc spraying include coating mild steel with Mo and fabricating tungsten rocket nozzles on graphite mandrels. Maximum plasma spray particle sizes are given for the refractory metals and for 304 stainless TaC, BeO and ZrO_2.

Missel, L. and G. R. Greear
PLATINUM BLACK COATING OF BERYLLIUM. Paper Presented at the Los Angeles Meeting, The Electrochemical Society, no. 171, May 6-10, 1962.
A method for the application to Be of an adherent platinum black coating providing high thermal emittance over a large temperature interval is developed. Comparison is made with coatings formed by chromic acid anodizing, whose emittance is marginal and diminishes above approximately 1100°F.

MacPherson, B. M. and W. W. Beaver
NEW DEVELOPMENTS IN BERYLLIUM JOINING. American Welding Society, 43rd Annual Meeting, April 1962, Technical Abstract.

National Bureau of Standards, v. 45: 178-179 (October 1961)
EFFECT OF DODECYL ALCOHOL ON FATIGUE CRACK PROPAGATION. Technical News Bulletin.

O'Boyle, Dennis
SURFACE COATINGS FOR BERYLLIUM PARTS. Machine Design, v. 33: 147-150 (December 1961)
Natural and anodic oxidation, electroplating, plating and flame spraying of Be parts to improve corrosion and wear resistance.

Paprocki, S. J. , E. S. Hodge, and P. J. Gripshover
GAS PRESSURE BONDING. Materials in Design Engineering, v. 55: 14-15 (March 1962)
Conditions of gas pressure bonding used for joining Be, Al, Mo, Cb, Zr, Ti, Cr and stainless steel and for consolidating uranium dioxide, uranium nitride, uranium carbide, aluminum oxide, beryllium oxide and magnesium oxide powders and for cladding brittle materials.

Paprocki, S. J. , E. S. Hodge, and P. J. Gripshover
GAS PRESSURE BONDING. Light Metal Age, v. 19: 17, 20, 22-23 (December 1961)
Solid-state bonding of Be, Al, Ti, Fe-Cr-Al alloy and Al, Be and Mg oxides in an autoclave with an inert gas atmosphere at high temperature and under high isostatic pressure. Application to joining, cladding, and densifying material systems.

Snavely, Cloyd A. and Charles L. Faust
METAL SURFACE PREPARATION AND CLEANING. PT. G. OXIDE REMOVAL. Chapter 3 from ELECTROPLATING ENGINEERING HANDBOOK. 2nd Ed. Reinhold Publishing Corp. , New York, 1962, p. 176-189.
Character of oxide and scales on metals; reactions between oxides and acids; pickling and bright dipping procedures; recommended materials for pickling equipment.

Sprowl, J. D.
THE PRODUCTION AND USES OF ALUMINIZED STEEL. Iron and Steel Engineer, v. 38: 97-103 (October 1961)
Production of materials with coatings of Al with additions of Fe, Si, Na, Be, B, Ti, Cr, Mo, Zr, V, W and Mg applied by hot dipping, electroplating, cementation, spraying and cladding. Physical properties and corrosion resistance.

Stephas, Paul
SEARCH FOR A NUCLEAR THERMIONIC EMITTER. Nucleonics, v. 19: 66, 70, 72-73 (December 1961)
A literature survey for materials suitable as coatings for nuclear fuels, comprising more than 100 elements and binary compounds with melting temperatures over 2000°C, low evaporation rate, low neutron cross section, noncondensable vapor pressure and large thermionic current density.

Turner, Arthur
MATERIAL CONSERVATION BY METAL DEPOSITION. Production Engineer, v. 40: 665-673 (October 1961)
Application of abrasion and corrosion resistant coatings by painting, hot dipping, electroplating, vapor plating, electroless plating, thermonuclear diffusion welding and flame spraying. Evaluation of wire, powder and plasma flame spraying processes. Reclamation of mis-machined parts. Importance of surface preparation. Alloys for fused coatings, oxidation resistant alloys and ceramics. Plastic spraying.

Watkins, H. and A. Kolk
MEASUREMENT OF STRESS IN VERY THIN ELECTRODEPOSITS. Electrochemical Society Journal, v. 108: 1018-1023 (November 1961)
A modified form of the Brenner-Senderoff contractometer, with greater sensitivity achieved by using jeweled bearings and optical readout, is used to study initial growth and stress of the plating in thin films of Ni prepared from a sulphamate bath and high Fe, low Ni alloys prepared from a variation of the ferrous chloride-calcium bath with slight additions of $NiCl_2$. Stress-thickness relations are calculated, with metallographic observation of grain boundary and microstructures of the films.

Weik, H.
PLASTIC DEFORMATION OF BERYLLIUM. Metall, v. 15: 686-694 (July 1961) (German)

Whitby, L., E. Gowen, and D. J. Levy
CHROMIC ACID ANODIZING OF BERYLLIUM: PROCESS PARAMETER. Paper from 48th ANNUAL TECHNICAL PROCEEDINGS. American Electroplaters' Society, Inc., Newark, 1961, p. 106-108.
Be coupons are anodized in a chromic acid electrolyte at constant current density varied from 20-200 amps per sq ft at 25-50°C. Effect of chromic acid concentration, current density and temperature on process efficiency and the density and thickness of anodic coatings.

Alluminio Nuova Metallurgia, v. 31: 31-35 (January 1962)
USE OF TITANIUM, ALUMINUM AND MAGNESIUM ALLOYS FOR MISSILES. (Italian)

American Electroplaters' Society, Inc., Newark, 1961, 232p.
48th ANNUAL TECHNICAL PROCEEDINGS.

Accelerated corrosion tests, microscopic study of Cr plating vinyl coatings and finishes, anodizing and electroplating Al and Mg alloys. Anodizing Be, quality controlled problems in electroplating, corrosion protection of bright decorative automibile trim, electroplating Zn base die castings. Corrosion current data for Ni-Cr couples. Electrolists Ni plating on Ti alloys anodic behavior of metals in cleaning media, Cu bonding using copper oxide vapor deposition using Al, precious metal plating and solderability of electroplated coatings. Plating of printed circuits and production of ultra high frequency electronic parts.

American Electroplaters' Society, Inc., Newark, 1961, p. 109-111.
CHROMIC ACID ANODIZING OF BERYLLIUM-PROCESS DEVELOPMENT. Paper from 48th ANNUAL TECHNICAL PROCEEDINGS.

Characteristics of Be surfaces and their influence on anodic coatings. Performance of black anodic coatings in salt spray corrosion tests. Procedures for mechanical preparation, alkaline cleaning, chemical polishing, and chromic acid anodizing of Be.

Ceramic Age, v. 76: 25-26 (December 1960)
BeO AT NATIONAL.

Chemical & Engineering News, v. 39: 80 (October 1961)
COATINGS FOR NUCLEAR FUELS EXPLORED.

Corrosion resistant coatings of Cb, Cr, V, Si, Mo, Be, W, Cr-Ni and Cb-Zr are applied to UO_2 particles using hydrogen reduction of metallic chlorides in a vibrating reactor apparatus. Use of a fluidized bed technique for vapor deposition of ceramic coatings, including aluminum oxide, beryllium oxide, magnesium oxide and pyrolytic carbon, at 500-900°C.

Electroplating and Metal Finishing, v. 14: 423-424 (November 1961)
DEPOSITION OF PLATINUM GROUP METALS BY CHEMICAL DISPLACEMENT.

Preparation and plating of Cu, brass, beryllium copper and nickel silver with Pt, Pd, Rh and Ru. Sealing of porous deposits using a Au plating solution, ammonium hydroxide solution or boiling distilled water.

Iron Age, v. 188: 72-73 (October 1961)
NBS CONQUERS METAL FATIGUE.

Machinery (London), v. 97: 1179-1181 (November 1960)
SOME APPLICATIONS OF ELECTROPOLISHING.

Use of electropolishing to remove burrs, avoid stress concentration and to remove discoloration caused by heat treatment. Application to stainless, carbon and alloy steels, Ni, Ni alloys, Cu and Cu alloys.

Materials in Design Engineering, v. 54: 129-132 (November 1961)
COATINGS FOR THE REFRACTORY METALS.

Silicide, beryllide, aluminide, Zn and cermet protective coatings for Mo, Cb, Ta and W for high temperature application. Determination of coating ductility, thickness, melting point, heat and oxidation resistance, brittleness and maximum life.

Metal Industry, v. 98: 50 (January 1961)
OXIDATION PREVENTION DURING FORMING.
Method of precoating metals used in aircraft production by spraying with Al or Cu to prevent oxidation and material loss during thermal treatment such as hot forming, stress relieving, heat treating or annealing.

Products Finishing, v. 25: 78, 82-83 (July 1961)
EFFECT OF ORGANIC COMPOUNDS ON METAL FATIGUE.

Reactor Core Materials, v. 3: 30-47 (November 1960)
CLADDING AND STRUCTURAL MATERIALS.

Steel, v. 148: 116-117 (February 1961)
VIBRATION FINISHING ENDS DEFORMATION OF RIGHT PARTS.
Vibration deburring is used for cleaning, descaling, radiusing, coloring and internal finishing of small spring metal parts.

AD-271436
Rolla Metallurgy Research Center, Bureau of Mines, Mo.
VAPOR DEPOSITION OF TUNGSTEN AND THE EFFECTS OF PROCESS VARIABLES. MONTHLY PROGRESS REPORT NO. 3. F. W. Hoertel. January 1962. 4p. incl. illus.

ARB-10706
BERYLLIA – A REPORT BIBLIOGRAPHY. June 1962. 20p.

ASD-TR-61-147
Honeywell Research Center, Hopkins, Minn.
NORMAL SPECTRAL REFLECTANCE OF ANODIZED COATINGS ON ALUMINUM, MAGNESIUM, TITANIUM AND BERYLLIUM.
J. E. Janssen, R. H. Torborg, J. R. Luck, and R. N. Schmidt. June 1961. 289p. (Contract AF 33(616)-6191).

BMI-1545
Battelle Memorial Inst., Columbus, Ohio
PRELIMINARY STUDIES OF BONDING OF BERYLLIUM-CLAD UO_2 FUEL ELEMENTS. Stan J. Paprocki, Edwin S. Hodge, and James S. Perrin. September 1961. 20p. (Contract W-7405-eng-92)
Gas-pressure bonding of Be clad UO_2 fuel elements at 1550-1650°F using chromium or pyrolytic carbon coatings to prevent Be-OU_2 reaction. Data given on grain recrystallization.

DMIC-Memo-85
Defense Metals Information Center, Battelle Memorial Institute
PICKLING AND DESCALING OF HIGH-STRENGTH, HIGH-TEMPERATURE METALS AND ALLOYS. J. A. Gurklis and L. D. McGraw. February 1961. 16p.
Cleaning of Be, Ti, Mo, Cb, Ta, W, V and highly alloyed metals such as stainless steel and Ni, Co and Fe base alloys using H_2SO_4, HCl, HF and HNO_3 in pickling and sodium hydroxide in descaling. Temperature, agitation, chemical properties of metals and surface desired are influencing factors.

DMIC-Memo-98

Defense Metals Information Center, Battelle Memorial Institute
ELECTROPOLISHING AND CHEMICAL POLISHING OF HIGH-STRENGTH, HIGH-TEMPERATURE METALS AND ALLOYS. J. A. Gurklis, L. D. McGraw, and C. L. Faust. April 1961. 14p.

Chemical and electropolishing of 300 and 400 stainless steels, Nimonic 80, Waspalloy, S-816 alloy, AMS 5615 alloy, Be, Ti and Te alloys, Cb, Ta, V and W to remove burrs, provide dependable anti-friction surfaces and improve corrosion resistance because of the absence of differential surface stresses caused by mechanical finishing.

DMIC-Report-159

Defense Metals Information Center, Battelle Memorial Institute
GAS-PRESSURE BONDING. S. J. Paprocki, E. S. Hodge, and P. J. Gripshover. September 1961. 42p.

NDA-2162-1

Nuclear Development Corp. of America, White Plains, N. Y. and Carborundum Co., Niagara Falls, N. Y.
CARBIDE FUEL DEVELOPMENT. PROGRESS REPORT, PERIOD OF SEPTEMBER 15, 1960 - JANUARY 31, 1961. A. Strasser and K. Taylor. February 1961.

NEPA-1425

Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.
PROGRESS IN THE DEVELOPMENT OF CERAMIC GLAZE COATINGS FOR BERYLLIUM CARBIDE UNDERBODIES. Murray A. Schwartz and W. J. O'Leary. April 1950. Decl. July 1961. 18p. (Contract W-33-08-ac-14801(16250))

Techniques for producing uniform, thin, vitrified ceramic coatings on beryllium carbide-rich fuel rod shapes. The coatings are formed on the surface of the compacts by firing the pieces in a furnace subsequent to their being sprayed with slips containing fritted oxides. Development of a glassy coating in the Mo resistance furnace.

NEPA-1517

Battelle Memorial Inst., Columbus, Ohio
PROTECTIVE COATINGS FOR BERYLLIUM CARBIDE-BEARING FUEL-ELEMENT BODIES. H. E. Wagner, H. F. Reid, L. S. O'Bannon, and C. G. Harman. June 1950. Decl. September 1961. 70p. (Contract W-33-08-ac-14801(16250))

Determination of the protective quality of fuel element coatings against oxidation at 2500°F with 0-5% UC additions and the relation of the protection to the underbody porosity.

NYO-9187

Nuclear Materials and Equipment Corp., Apollo, Penna.
FINAL REPORT (ON CORROSION AND RADIATION DAMAGE RESISTANT FUEL MATERIAL) NOVEMBER 15, 1959 THROUGH NOVEMBER 14, 1960. 130p. (Contract AT-(30-1)-2264)

Development of coating procedures for depositing Cb, Cr, Mo, Cb-5 V alloy, Si and Be on UO_2 spheres and Cr on U spheres. Coatings evaluated by chemical and metallurgical methods to determine purity, hardness and corrosion resistance. The resulting coated spheres are used in the fabrication of dispersion type fuel elements by extrusion.

Patent - British 832,807

IMPROVEMENTS IN OR RELATING TO METAL COATINGS. Leslie Mark Wyatt (to United Kingdom Atomic Energy Authority) April 13, 1960

A fuel cladding process and furnace are described. The cladding is applied by compacting metal powder around the fuel, sealing in a sheath, and subjecting to heat and gas pressure in a furnace. The process is especially suitable for Be cladding which is brittle and toxic. The furnace is enclosed in a pressure vessel which has a gland chamber for passing articles to be clad in and out of the furnace without depressurizing. The motor-driven mechanism for moving articles through the process is described.

Patent - British 843,054

IMPROVEMENTS IN AND RELATING TO THE COATING OF METALLIC SURFACES. (to Pyrene Co., Ltd.) August 4, 1960.

A method for covering titanium, zirconium, beryllium, and their alloys with a complex fluoride coating is given for the purpose of improving the cold-working properties of the metals and consists of dipping the metal surface in a solution containing more than 2 wt % of a complex acid of fluorine. In this way, coatings of 1 to 10 g/m^2 may be obtained. The solution may also contain HF or simple fluorides, and it may contain a surface-active agent, preferably a nonionic polyoxyethylene derivative, to make the coating action more uniform. Four applications of this method are given for titanium, using fluosilicic, fluoboric, fluophosphoric, and fluosulfonic acids, the last being least effective in giving the surface an adsorptive coating.

Patent - U.S. 3,013,328

METHOD OF FORMING A CONDUCTIVE FILM. J.E. Beggs. December 19, 1961.

Formation of a resistance film of Ti, Zr, Hf, Th or Ta on ceramic substrates by first coating the substrate with a carbon compound which when decomposed leaves a carbon residue, placing a metal hydride in contact with the coating and heating the assembly to decompose the hydride, combine the remaining metal with the ceramic and form the carbonaceous binder.

SCNC-320

Sylvania-Corning Nuclear Corp., Bayside, N.Y.

HIGH TEMPERATURE OXIDATION RESISTANT COATINGS FOR TANTALUM BASE ALLOYS. SECOND QUARTERLY PROGRESS REPORT, SEPTEMBER 1, 1960 – NOVEMBER 30, 1960.

Evaluation of aluminide and beryllide coatings applied to pure tantalum and Ta-10% W sheet by hot dipping in Al and Sn-base baths, slurry painting of Al alloys and vapor-solid reactions for Be. Heat resistance is measured and stability of surface compounds investigated metallographically.

WADD TR 60-32

Nuclear Metals, Inc., Concord, Mass.

BERYLLIUM RESEARCH AND DEVELOPMENT IN THE AREA OF COMPOSITE MATERIALS. REPORT FOR JUNE 15, 1958 – JUNE 14, 1959 ON METALLIC MATERIALS. Jacob Greenspan, Gerald A. Henrikson, and Albert R. Kaufmann. July 1960. 108p. incl. illus., tables. (Contract AF 33(616) 5912, Proj. 7351)

SECTION V. BERYLLIUM METALLURGY
PART K. METALLOGRAPHY, CONSTITUTION, AND PRIMARY STRUCTURE

Amitani, Toshio
THE EFFECT OF SMALL AMOUNTS OF ADDITIONAL ELEMENTS ON THE ANISOTROPIC PROPERTIES OF ANNEALED ALUMINIUM SHEETS. Japan Institute of Metals Journal, v. 25: 170-173 (March 1961) (Japanese)

Deep drawing tests on 400-450°C annealed Al sheet specimens containing about 0.3% addition of Pb, Si, Sb, Ni, Fe, Be, Ti, Zr, Cr, Mn, Cu, Li, Mg and Zn. Influence of addition elements on recrystallized grain size and anisotropy (earing).

Baker, T. W.
INTERATOMIC DISTANCES IN THE INTERMETALLIC COMPOUNDS $MgBe^{13}$ AND $CaBe^{13}$. Acta Crystallographica, v. 15, no. 3: 175-179 (March 1962)

$CaBe^{13}$ is produced by oxide reduction and $MgBe^{13}$ by cold pressing Be powder and immersing in molten Mg at 750°C with subsequent water quenching. X-ray diffraction measurements are used to determine the lattice parameters, atomic positions and line intensities.

Bakish, Robert
ELECTRON BEAM WELDING TECHNIQUES AS APPLIED TO AEROSPACE STRUCTURES. Society of Automotive Engineers, v. 514A: 10p. (1962)

Barnes, R. S. and G. W. Greenwood
PHYSICAL METALLURGY AND SOLID STATE PHYSICS IRRADIATION EFFECTS. PT. 1. THE EFFECT OF GASES PRODUCED IN REACTOR MATERIALS BY IRRADIATION. Chapter 2 from PROGRESS IN NUCLEAR ENERGY. Series 5. METALLURGY AND FUELS. Vol. 3. Pergamon Press Inc., New York, 1961, p. 195-206.

The role of vacancy diffusion in the precipitation of gas atoms and the formation of bubbles is studied by metallographic observation of the precipitation of He bubbles within Cu and Be subjected to temperatures up to 1000°C.

Barnes, R. S. (Atomic Energy Research Establishemnt, Harwell, Berks, England)
RADIATION EFFECTS IN CLADDING MATERIALS. p. 93-104 of FUEL ELEMENT FABRICATION WITH SPECIAL EMPHASIS ON CLADDING MATERIALS. VOLUME 2. London and New York, Academic Press, 1961.

Bastien, P. and P. Pointu
DETERMINATION OF GLIDE ELEMENTS IN HEXAGONAL METALS BY ASTERISMS IN LAUE PHOTOGRAPHS AND APPLICATION TO THE STUDY OF DEFORMATION OF BERYLLIUM AT HIGH TEMPERATURES. Journal of Nuclear Materials, v. 5: 101-108 (January 1962) (French)

Bastien, P. and P. Pointu
MODES OF DEFORMATION OF BERYLLIUM AT HIGH TEMPERATURE AND RECRYSTALLIZATION AFTER TWINNING. Journal of Nuclear Materials, v. 5: 153-155 (January 1962) (French)

Belyaev, A. P. and R. M. Gol'shtein
EFFECT OF SMALL Ti, Be, Ga, Re AND Cb ADDITIONS ON THE GRAIN SIZE OF Al AFTER DEFORMATION AND HEATING. Metallovedenie i Termicheskaya Obrabotka Metallov: 37-38 (July 1961) (Russian)

An Al ingot containing 0.05-0.21% Ti, 0.05-0.22% Be, 0.06-0.23% Cb, 0.008-0.24% Re or 0.029-0.48% Ga is hot and cold rolled and annealed. Samples for mechanical testing are cut from the sheet, annealed at 350°C, subjected to a tensile deformation of 1.5-15%, heated up to 500°C in a salt bath and etched to reveal the grain.

Belford, Geneva G., Robert A. Bernheim, and H. S. Gutowsky
CHARGE DISTRIBUTION AND ELECTRIC FIELD GRADIENTS IN IONIC CRYSTALS. Journal of Chemical Physics, v. 35: 1032-1038 (September 1961)

Study of nuclear quadrupole moment, electric field gradient asymmetry parameter and crystallographic parameters of beryl and spodumene on the basis of a quadrupole interaction.

Brackett, Thomas E. and Elizabeth B. Brackett
BINDING ENERGIES OF THE GASEOUS ALKALINE EARTH HALIDES. Journal of Physical Chemistry, v. 66, no. 8: 1542-1543 (August 1962)

Binding energy of Be, Mg, Ca, Sr and Ba halide is calculated at 0°K by Rittner's method in terms of the polarizability of the halide ion, internuclear distance, dipole moment, stretching frequency and ionic model.

Brown, A. B., A. J. Martin, and J. Morrow
THE EFFECT OF STRAIN RATE AND HEAT TREATMENT ON THE TENSILE PROPERTIES OF EXTRUDED BERYLLIUM RODS BETWEEN 25 AND 600°C. Less-Common Metals Journal, v. 3: 62-88 (February 1961)

Extruded bars of Be ingot and sintered powder are tested in tension with subsequent examination by fractography, metallography, crystallography, hot hardness and yield point measurement and chemical analysis after annealing at 400-700°C. Mechanical property values particularly ductility, structural phenomena are correlated with impurity precipitation from solution, strain rates and temperature of heat treatment.

Clegg, A. B., K. J. Foley, G. L. Salmon, and R. E. Segel
GAMMA RADIATION FROM THE MEDIUM ENERGY PROTON BOMBARDMENT OF LITHIUM, BERYLLIUM, BORON, CARBON AND NITROGEN. Physical Society (London) Proceedings, v. 78: 681-694 (November 1961)

Measurements, using an NaI(Tl) scintillator crystal counter, of the gamma ray spectrum, cross section, inelastic scattering and nuclear structure.

Coffinberry, A. S.
LATER PLUTONIUM METALLURGICAL RESEARCH AT LOS ALAMOS. Chapter 5 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Illinois, 1961, p. 36-62.

Crawford, J. H., Jr.
PHYSICAL METALLURGY AND SOLID STATE PHYSICS IRRADIATION EFFECTS. PT. 14. RADIATION STABILITY OF NONMETALLIC STRUCTURES. Chapter 2 from PROGRESS IN NUCLEAR ENERGY. Series 5. METALLURGY AND FUELS. Vol. 4. METALLURGY OF NUCLEAR REACTOR COMPONENTS. Pergamon Press, Inc., New York, 1961, p. 371-392.

Reactor studies of refractory nonmetallic material properties including phase transformations in ZrO_2 and $BaTiO_3$, investigated by X-ray diffraction, structural stability of diamond, Ge, Si, InSb, GaSb, SiC and NaCl, structure, magnetic susceptibility modulus, Knoop hardness, thermal conductivity and density of Al_2O_3, TiO_2, ZrO_2, quartz and mica and thermal resistivity and dimensional stability of BeO.

Crossley, F. A., A. G. Metcalfe, and R. P. Elliot
ORIENTATION OF CAST BERYLLIUM. Metallurgical Society of AIME, Transactions, v. 221: 890 (August 1961)

The texture method (using monochromatic Cu radiation) is used to determine the orientation of the columnar grains of vacuum induction melted and vacuum cast Be ingots. X-ray De Bye patterns show no preferred orientation due to the occurrence of a phase transformation above 1250°C which masks the original solidification orientation.

Croutzeilles, M. and A. Saulnier
INTERPRETATION OF ELECTRON DIFFRACTION DIAGRAMS APPLICABLE TO METALLOGRAPHY. Metaux Corrosion-Industries, v. 36: 341-367 (October 1961) (French)

Determination of crystal, lattice, recrystallized and epitaxial structures, Ewald construction, oxide layers, phases and crystal orientation in rolled and fritted Be, Al and alpha iron monocrystals, Ti-Al alloy, cast A-G15 Al alloy, heat treated (250°C) Al-Si alloy, Al-Cu alloy, U, heat treated (190-540°C) Cu-Be alloy, Al-Zn alloy, Ti sheet, cast Al-Mn alloy, heat treated (120°C) Al-Mg alloy and heat treated (250°C) Al-Ag alloy by electron microdiffraction.

Das, T. P. and M. Pomerantz
NUCLEAR QUADRUPOLE INTERACTION IN PURE METALS. Physical Review, v. 123: 2070-2076 (September 1961)

Calculations of the ionic electric field gradient at the nuclei of Be, Sc, Re, La, Mg, Co, Zn and In are combined with available experimental data to obtain information about the electronic structures, nuclear quadrupole moment and shape of the Fermi surface.

Dingle, J. H. and A. Moore
A RAPID ELECTROLYTIC METHOD FOR THE PREPARATION OF METALLOGRAPHIC SURFACES ON FABRICATED BERYLLIUM. Institute of Metals Journal, v. 90: 270-271 (March 1962)

Ellinger, F. H.
A REVIEW OF THE INTERMETALLIC COMPOUNDS OF PLUTONIUM. Chapter 25 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Illinois, 1961, p. 281-307.

Crystallographic data are presented for known intermetallic compounds of Pu with 32 elements including transition metals and radioactive heavy metals, with discussion of isotypes and interatomic distances.

Emel'janov, V. S., J. G. Godin, A. I. Evstjuchin, and A. A. Rusakov
PHASE DIAGRAM FOR ZIRCONIUM-BERYLLIUM. Kernenergie, v. 4: 228-232 (March 1961) (German)
Construction of binary phase diagrams for all concentrations of the system from thermal analysis, metallographic and Z-ray investigation and by hardness measurements. Formation of intermetallic phases $ZrBe_2$, $ZrBe_6$, $ZrBe_9$ by peritectic reactions is observed at 1235, 1475, and 1555°C, respectively.

Evans, Doris
EARLY AGING EFFECTS IN COPPER-1.76% BERYLLIUM SINGLE CRYSTALS. ADVANCES IN X-RAY ANALYSIS, VOL. 1. Plenum Press, Inc., New York, 1960, p. 143-162.
X-ray and optical micrographic and X-ray diffraction examination of age-hardening mechanisms in specimens aged 6-27 hr at 200°C. Earliest stages of aging show distortion and fragmentation of the matrix lattice and evidence of order-disorder transformation. Data given for reflection curves and mechanical properties.

Evans, W.
THE METALLOGRAPHY OF REACTIVE MATERIALS. Canadian Mining and Metallurgical Bulletin, v. 53: 893-900 (November 1960)
Methods for cutting, grinding and polishing U, UO_2, Zr, Zr alloys and Be for metallographic study. Techniques for determining grain structures and identifying phases.

Fischer, G.
ULTRASONIC WELDING MACHINES. Mecanique et Electricite, v. 46: 29-38 (January 1962) (French)

Fishlock, David
ETCHING MAKES INROADS INTO MILLING, PRESSING, BLANKING. Metalworking Production, v. 105: 77-78 (November 1961)
Applications of chemical etching in the manufacture of etched-foil printed circuitry, "printed" motor winding and electric shaver foils and in contour etching of airframes and missile components. Etching properties of Al, Be, high tensile Cr-Mo steel and Ti and Ti alloys.

Garber, R. I. and I. A. Gindin
THE PHYSICAL PROPERTIES OF METALS OF HIGH PURITY. Soviet Physics — Uspekhi, v. 4: 405-424 (November-December 1961) (Translation-AIP)

Garber, R. I. and I. A. Gindin
PHYSICS OF THE STRENGTH OF CRYSTALLINE MATERIALS. Soviet Physics: 41-77 (July-August 1960) (Translation-AIP)

Garber, R. I., I. A. Gindin, and Yu. V. Shubin
STRESS OF BERYLLIUM SINGLE CRYSTALS IN THE TEMPERATURE RANGE 20-500°C. Fizika Metallov i Metallovedenie, v. 12: 437-446 (March 1961) (Russian)
Mechanical properties are studied with emphasis on ductility and failure under stress of Be single crystals. Effect of orientation.

Gladyshevskii, E.I., P.I. Kripyakevich, M. Yu Teslyuk, O.S. Zarechnyuk, and Yu. B. Kuz'ma
CRYSTAL STRUCTURES OF SOME INTERMETALLIC COMPOUNDS. Soviet Physics – Crystallography, v. 6: 207-208 (September-October 1961) (Translation-AIP)
Powder X-ray diffraction data (using Debye and Preston patterns) for lattice constants and superstructures of intermetallic compounds found in binary and ternary alloys containing Cb, Al, V, Fe, Si, Co, Ni, Ge, Mn, Ga, Ce, Cu, Mg, In, Zn, Nd, Ba, Ca, Ti, Sr, Be and Er.

Gordon, L.J. and J.B. Lee
METALS AS FUELS IN MULTICOMPONENT PROPELLANT. ARS Journal, v. 32: 600-606 (April 1962)

Grainger, I.
THE BEHAVIOUR OF REACTOR COMPONENTS UNDER IRRADIATION. Review Series, Developments in the Peaceful Applications of Nuclear Energy, No. 6: 62p. (1960)

Harris, L.A., R.A. Potter, and H.L. Yakel
PRELIMINARY OBSERVATIONS OF MIXED OXIDE COMPOUNDS CONTAINING BeO. Acta Crystallographica, v. 15, no. 6: 615-616 (June 1962)

Hickman, B.S., T.M. Sabine, and R.A. Coyle
X-RAY DIFFRACTION STUDIES OF IRRADIATED BERYLLIUM OXIDE. Journal of Nuclear Materials, v. 6, no. 2: 190-198 (July 1962)
Lattice parameter changes occurring in neutron irradiation of hot pressed beryllium oxide to integrated fission neutron doses of 1×10^{19} nvt to 3.5×10^{20} nvt at 75-100°C and to doses of $1\text{-}1.5 \times 10^{20}$ nvt at 500-650°C are reported. An anisotropic lattice expansion occurs, the expansion in the c direction being greater than the expansion in the a direction. Study is made of the effect of annealing at 1400-1500°C on complete recovery of the damage.

Hoenig, Clarence L., Carl F. Cline, and Donald E. Sands
INVESTIGATION OF THE SYSTEM BERYLLIUM-BORON. American Ceramic Society Journal, v. 44: 385-389 (August 1961)
X-ray single crystal and powder diffraction examination, chemical analyses and Knoop microhardness measurements are made of mixtures reacted under argon at 1100-1600°C to determine unit cell shape, hardness and melting point. An anistropic unknown phase is found which forms eutectic with Be at 972°C and whose hardness depends on orientation.

Hoffman, J.A., G.R. Baxter, R.C. Bertossa, and B.R. Cottrell
DIFFUSION BONDING BERYLLIUM COPPER FOR ULTRA HIGH STRENGTH JOINTS. Welding Journal, v. 41: 160s-166s (April 1962)

Honeycombe, R.W.K.
THE EFFECT OF TEMPERATURE AND ALLOYING ADDITIONS ON THE DEFORMATION OF METAL CRYSTALS. Paper from PROGRESS IN MATERIALS SCIENCE. Vol. 9. Pergamon Press, Inc., New York, 1961, p. 93-130.
A review of the experimental data including is interpretation in terms of dislocation theory, relevant to the effects of temperature and alloying additions on the critical resolved shear stress and the stress-strain curve for pure metal and solid solution crystals.

Houle, M. C. and R. L. Coble
CERAMOGRAPHIC TECHNIQUES. PT. 1. SINGLE PHASE, POLYCRYSTALLINE, HARD MATERIALS. American Ceramic Society Bulletin, v. 41: 378-381 (June 1962)
Preparation of polished sections of hard single phase MgO, BeO, UO_2, ZrO_2, Cr_2O_3 and Al_2O_3 by various techniques of mounting, grinding, polishing and etching for microscopic examination in reflected light.

Jacquet, Pierre A.
NONDESTRUCTIVE METALLOGRAPHY OF LIGHT AND ULTRA-LIGHT MATERIALS (ALUMINUM, MAGNESIUM, BERYLLIUM AND THEIR ALLOYS). Revue de l'Aluminum, v. 37: 835-842 (July-August 1960) (French)
Ellopol technique (electrolytic buffer method) of surface preparation. Use of a group of patented electrolytes and their suitability for specific materials. Use of replicas.

Jacquet, Pierre A.
NONDESTRUCTIVE METALLOGRAPHY OF Al, Mg, Be AND THEIR ALLOYS. CONCLUSION. Revue de l'Aluminum, v. 37: 977-987 (September 1960) (French)
Local electrolytic polishing and etching of semiproducts using a plug of cotton or fabric containing the electrolyte, a current being passed through the semiproduct and the electrolyte during application.

Jacquet, Pierre A.
NONDESTRUCTIVE METALLOGRAPHY OF LIGHT AND ULTRA-LIGHT MATERIALS (ALUMINUM, MAGNESIUM, BERYLLIUM AND THEIR ALLOYS). Revue de l'Aluminum, v. 37: 713-20 (June 1960) (French)
The electrolytic plus ("Ellopol" process) performs, on small specimens as well as on every accessible area of a part, the polishing and anodic processes required in optical and electronic metallography. When the shape or size of the object does not allow direct observation under the microscope, a print of the surface is substituted; the print is obtained with a special varnish; it can also provide a backing to a carbon film which will be examined in the electronic microscope. The combination of the two processes (local preparation and replica) leads to a new form of metallography, referred to as nondestructive. Offering interesting applications in metallurgical investigations, this process is most suitable for production line checks and for finished articles. The transparency of the replica simplifies conditions of observation. The present report, limited to the light and ultra-light metals and alloys used in the aircraft and nuclear industries, describes the main points of the processes and provides some examples of the results obtained.

Jahnle, H. A.
RESISTANCE SPOT WELDING BERYLLIUM SHEET. American Welding Society, 43rd Annual Meeting, Technical Abstract. (April 1962)

Jones, L. V., D. E. Etter, and C. R. Hudgens
PHASE EQUILIBRIA IN THE TERNARY FUSED-SALT SYSTEM $LiF-BeF_2-UF_4$. American Ceramic Society Journal, v. 45: 79-83 (February 1962)
The phase diagram for the system is determined from 300°C to the liquids by differential thermal analysis, thermal-gradient quenching

studies and high temperature filtration techniques. The samples prepared by quenching are examined by polarized-light microscopy and X-ray diffraction techniques.

King, R. and A. P. Grunaugh
ELECTRICAL MEASUREMENTS. Paper from THE PHYSICAL EXAMINATION OF METALS. Edward Arnold, Ltd., London, England, 1960, p. 81-167.
Survey of electrical resistivity measurement principles and techniques including a-c. and d-c. methods and relation of electrical resistivity changes to structural and compositional changes in metals. Application in metallographic research determining constitutional diagrams, order-disorder transitions, phase transformations and the effect of lattice defects on resistivity of pure metals, alloys and metal surfaces.

Kirchner, Henry P.
APPLYING ATOMIC STRUCTURE KNOWLEDGE TO MATERIALS RESEARCH. Research Trends, v. 10, no. 1: 5-7 (1962)
Determination of the temperature effects (up to 1200°C) on thermal expansion properties of pure, single and double phase ceramic materials and solid solutions, including corundum (Al_2O_3), alpha silicon carbide (SiC), tetragonal barium titanale ($BaTiO_3$), cubic uranium pyrophosphate (UP_2O_7), ruptile (TiO_2), spinel ($MgAl_2O_4$), Be, graphite and molybdenum disilicide utilizing X-ray diffraction and dilatometry.

Kobrin, C. L.
MAN-MADE MATERIALS. Iron Age, v. 189: 109-116 (April 1962)
Development of synthetic materials including gems and other crystal forms, reinforcing metals, plastics, concrete, graphite, rubber and composites for metallurgical applications.

Komjathy, S.
THE CONSTITUTION OF SOME VANADIUM-BASE BINARY AND TERNARY SYSTEMS AND THE AGING CHARACTERISTICS OF SELECTED TERNARY ALLOYS. Journal of the Less-Common Metals, v. 3: 468-488 (December 1961)
Binary (V-Sn, Hf, W, Re, Th) and ternary systems (Ti-Cb, Ti-Mo, Ti-Ta, Ti-W, Ti-Be, Ti-O, Ti-Si) are investigated by metallography and X-ray diffraction and melting point measurements to determine the extent of the vanadium-rich solid solution between 800 and 1500°C, the character of the second phase in equilibrium with the solid solution and melt reactions, the age hardening of selected V-Ti-Be, Ti-O and Ti-Si alloys is studied at 550, 650 and 750°C.

Kostin, N. F., S. V. Lubenets, and K. S. Aleksandrov
SELECTIVE ETCHING OF SODIUM CHLORIDE CRYSTALS. Soviet Physics – Crystallography, v. 6: 588-593 (March-April 1962) (Translation-AIP)
Etch pits and dislocations as influenced by ethyl alcohol etchants containing additions of $CdCl_2$, $CdBr_2$, CdI_2, cadmium acetate, barium acetate, $SnCl_2$, $MnCl_2$, $MnSO_4$, $HgCl_2$, $PrCl_3$, $Ca(NO_3)_2$, $BiCl_3$, $SrCl_2$, $CrCl_2$, KI, BaI_2, KOH, NaOH, $BaBr_2$, KCl and $BeCl_2$.

Kratochvil, J.
ELASTIC STRESS AROUND LINEAR DISLOCATION IN ANISOTROPIC MEDIUM. Czechoslovak Journal of Physics, v. 11: 324-335 (May 1961) (English)

Equations are derived for the elastic stress field in an infinite medium, using the anistropic theory of elasticity. Application of results to the calculation of field around cracks in crystals of Mg, Cd, Zn, Be and Te provide values for elastic, shear and Young's modulus, stress tensor and shear and tensile strength.

Kripyakevich, P. I. , M. A. Tylkina, and E. M. Savitskii
CRYSTAL STRUCTURES OF HAFNIUM-BERYLLIUM COMPOUNDS. Soviet Physics — Crystallography, v. 6: 94 (July-August 1961)

Alloys prepared by melting 0.0025-51.64 at. % Hf in an Ar atmosphere in a high frequency or electric arc furnace are examined by X-ray structural analysis. Determination of melting point, microhardness and lattice structure for the three compounds existing in the system.

Kripyakevich, P. I. , M. A. Tylkina, and E. M. Savitskii
CRYSTAL STRUCTURES AND CERTAIN PROPERTIES OF HAFNIUM-BERYLLIUM COMPOUNDS. Journal of Structural Chemistry, v. 2: 395-402 (July-August 1961) (Translation-ConBur)

Melting point, hardness microstructure and microhardness of Hf-Be compounds prepared by high frequency vacuum furnace in argon. Crystal structure of $HfBe_{13}$, $HfBe_2$, $HfBe_5$ and Hf_2Be_{17} by X-ray structural analysis and microstructural analysis.

Kripyakevich, P. I.
TERNARY LAVES-PHASE IN THE SYSTEM MANGANESE-COBALT-BERYLLIUM. Dopovidi Akademii Nauk Ukrains'koi RSR: 1042-1044 (August 1961) (Ukranian)

X-ray determination of a cubic $MgCu_2$ type phase in the system after 400°C heat treatment for various times. Data are given for lattice parameters and microstructure.

Levinson, David W.
FIBER-REINFORCED STRUCTURAL MATERIALS. Machine Design, v. 34: 147-148, 150 (March 1962)

Likhachev, V. A.
MICROSTRUCTURAL STRAINS DUE TO THERMAL ANISOTROPY. Soviet Physics — Solid State, v. 3: 1330-1336 (December 1961) (Translation of Fizike Tverdogo Tela, v. 3: June 1961)

Second order thermal strains are assumed to appear in polycrystalline aggregates composed of grains with anisotropy thermal expansion with the effects of impurities and calculations for a 1° change in temperature. Results given for strain calculations.

Limb, H. R.
THE PROBLEM OF BRITTLE FRACTURE IN METALS. Australian Institute of Metals Journal, v. 6: 195-207 (August 1961)

Loewenstein, Paul
THE EXTRUSION OF BERYLLIUM. Current Engineering Practice, v. 4: 16-20 (February 1962)

Lundin, C. E.
RARE-EARTH PHASE DIAGRAMS. Chapter 16 from THE RARE EARTHS. John Wiley & Sons, Inc., New York, 1961, p. 224-385.
Alloying behavior is recorded by binary equilibrium phase diagrams for the 14 metals. Solubility relationships and crystallographic data are presented with a review of techniques including metallographic examination of polished and etched specimens, thermal analysis and X-ray diffraction analysis.

Markevich, G. S., Yu. D. Kondrashev, and L. Ya. Markovskii
A NEW BORIDE PHASE IN THE BERYLLIUM-BORON SYSTEM. Russian Journal of Inorganic Chemistry, v. 5: 865-867 (August 1960) (Translation)
X-ray diffraction analysis of the crystal structure and lattice parameters of Be_5B formed by compacting B and Be powders in atomic ratios from 1:9-1:2 and annealing at 1000-1100°C. Other properties investigated include electrical conductivity and resistivity, hydrolysis in acids forming suboxides and boron hydride formation in HCl.

Martin, A. E., J. B. Knighton, and H. M. Feder
SOLUBILITIES IN LIQUID ZINC – ZIRCONIUM, NIOBIUM, MOLYBDENUM, PALLADIUM AND THORIUM. Chemical and Engineering Data Journal, v. 6: 596-599 (October 1961)

Martinkevich, G. M.
MASS SPECTROPHOTOMETRIC DETERMINATION OF HEATS OF VAPORIZATION FOR MONOMERS AND BOND ENERGIES FOR DIMERS. Izvestiya Akedemii Nauk SSSR-Otdelenie Teknicheskikh Nauk - Metallurgiya i Toplivo, no. 1: 127-133 (January-February 1962) (Russian)

Mazza, Edmund
HYDROSTATIC-ISOSTATIC FORMING. Precision Metal Molding, v. 20: 38-41 (April 1962)

Meerson, G. A., D. D. Sokolov, N. F. Mironov, N. M. Bogorad, J. D. Pachomov, D. S. Lovovskij, E. S. Ivanow, and V. M. Smelev
BERYLLIUM. Kernenergie, v. 2: 939-945 (October-November 1960) (German)

Mondolfo, L. F.
A STATISTICAL APPROACH TO EQUILIBRIUM DIAGRAMS. Metallurgical Society of AIME, Transactions, v. 224: 164-180 (February 1962)
Investigation of the relationship between properties of the elements and type of binary diagram formed. Each type of equilibrium diagram, the factors for the size, valence, electro-negativity, period, melting point, entropies of fusion and sublimation calculated for each pair of elements cover a range of values but show sufficient relationship to the equilibrium diagram so that the correlation of several of them can be used to predict the type of diagram formed or at least limit the choice to only a few types.

Morinaga, Takuichi, Takeo Goto, and Tsuneo Takahashi
ANOMALOUS SOFTENING AND STRUCTURE CHANGE OF Cu-2% Be ALLOYS DUE TO DISCONTINUOUS PRECIPITATION. Japan Institute of Metals, Journal, v. 24: 777-781 (December 1960) (Japanese)

Muller, Erwin W.
DIRECT OBSERVATION OF CRYSTAL IMPERFECTIONS BY FIELD ION MICROSCOPY. Paper from DIRECT OBSERVATIONS OF IMPERFECTIONS IN CRYSTALS, Interscience Publishers, John Wiley & Sons, Inc., New York, 1962, p. 77-79.

Operational principles, capabilities, and typical design of the field ion microscope. Observations are made of vacancies, interstitials, impurity atoms, dislocations, and complex imperfections in W, Pt, Ni, Fe, and other metals. Application of field ion microscope to the investigation of defect structures due to fatigue and cold work.

Mueller, William M., Ed.
ADVANCES IN X-RAY ANALYSIS. Plenum Press, Inc., New York, 1960, 494p.

Proceedings of the 6th annual conference on industrial applications of X-ray analysis held at Denver, August 7-9, 1957. Topics include X-ray diffraction fluorescence, microscopy and absorption analysis of metals and alloys. Papers are abstracted separately.

Mackenzie, J. D.
STRUCTURE OF GLASS FORMING HALIDES. I. LIQUID BERYLLIUM FLUORIDE. J. chem. Phys., v. 32, no. 4: 1150-2 (April 1960)

Viscosity and electric conductivity measurements were made on liquid beryllium fluoride over the temperature range 700-950°C. The high specific resistance and viscosity and the magnitude of the corresponding energies of activation indicate that the classical random network structure for glasses is applicable. Liquid BeF_2, similar to liquid GeO_2 and SiO_2, is highly associated even at elevated temperatures. At a temperature 200° above the melting point, the energy of activation for viscous flow is greater than the heat of vaporization. The ease of glass formation is attributed to the network structure of the liquid.

McLean, D.
SEGREGATION, EMBRITTLEMENT AND SLIDING AT GRAIN BOUNDARIES. Paper from PROPERTIES OF GRAIN BOUNDARIES. (PROPRIETES DES JOINTS DE GRAINS). Press Universitaires de France, Paris, France, 1961, p. 85-94. (English)

Summary of research on grain boundary properties of Ni alloy, Fe-N, Fe-Ni and Fe-C alloys, mild steel, Au-Cu, Cu-Sb, Cu-Bi and Cu-Be alloys, beta brass, Al, Fe, Cu, Cd, Zn and Sn using electron microscopic, thin foil and quantitative techniques. Sliding as a function of grain deformation, size and temperature; embrittlement as a function of surface energy, grain boundary adsorption, solid-liquid interface energy and temperature; segregation as a function of grain boundary structure, dislocations, surface energy and alloy composition and radiation growth as a function of surface energy.

Newkirk, Arthur E.
PREPARATION AND CHEMISTRY OF ELEMENTARY BORON. Paper from BORAX TO BORANES. Advances in Chemistry Series, ACS, no. 32, 1961, p. 27-41.

Palatnik, L. S. and N. T. Gladkikh
MICROHETEROGENEITIES OF THE VACUUM CONDENSATION OF METALLIC VAPORS. Doklady Akademii Nauk SSSR, v. 140: 567-570 (March 1961) (Russian)
Cr, Pt, Ti, Fe, Co, Ni, Be, Cu, Au and Ag are evaporated in a vacuum of approx. 10^{-5} mm Hg pressure and allowed to condense on a Cu strip, one end of which is water cooled while the other end is heated, to create a temperature gradient. The transitions, vapor-liquid, vapor-liquid-solid or vapor-solid, as a function of support temperature are investigated by inspection, microscopy, X-ray diffraction and hardness measurements.

Plaksin, I. N. and V. I. Solnyshkin
THE EFFECT OF CAUSTIC SODA ON BERYLLIUM MINERAL SURFACE WHEN PREPARING IT FOR FLOTATION. Izvestiya VUZ — Tsvetnaya Metallurgiya: 28-35 (March 1961) (Russian)

Pointu, Pierre, Pierre Azou, and Paul Bastien
TWINNING OF BERYLLIUM AT HIGH TEMPERATURES AND RECRYSTALLIZATION AFTER TWINNING STUDIED BY AN OPTICAL METHOD FOR DETERMINING THE CRYSTALLOGRAPHIC AXES AND BY X-RAYS. Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, v. 253: 2084-2086 (November 1961) (French)
Effects of 1000 and 1070°C rolling and of 750 and 1000°C annealing on the structure of monocrystalline Be.

Popov, B. E. , S. F. Kovtun, and V. M. Amonenko
REDUCTION OF GRAIN SIZE IN BERYLLIUM AND CHROMIUM BY EXPOSURE TO ULTRA-SOUND DURING ARC MELTING. Fizika Metallov i Metallovedenie, v. 10: 853-856 (December 1960) (Russian)

Reinbach, Rudolf and Ursula Wilke-Dorfurt
FORMATION OF AN INTERMEDIATE PHASE IN THE AGING OF COPPER-BERYLLIUM ALLOYS. Zeitschrift fur Metallkunde, v. 52: 186-188 (March 1961) (German)

Rouberol, J. M. , M. Tong, E. Weinryb, and J. Philibert
AUTOMATIC SWEEPING DEVICE ON THE C. A. M. E. C. A. MICROPROBE. PRINCIPLE AND TYPICAL APPLICATIONS. Memoires Scientifiques de la Revue de Metallurgie, v. 59: 305-320 (April 1962) (French)

Rudy, E. , F. Benesovsky, H. Nowotny, and L. E. Toth
CRYSTAL STRUCTURE OF $HfBe_2$, $HfBe_{13}$ AND HfBeSi: PARTIAL SYSTEMS $MeBe_2$-MeB_2-$MeSi_2$ (Me = Zr, Hf). Monatshefte fur Chemie, v. 92: 692-700 (March 1961) (German)
X-ray powder investigation (Cu-K alpha radiation) of pressure-sintered (1200-1550°C) Hf-Be specimens and of specimens of the quasi-binary systems $HfBe_2$-$HfSi_2$, $ZrBe_2$-$ZrSi_2$, $ZrBe_2$-ZrB_2, $HfBe_2$-HfB_2, $ZrSi_2$-ZrB_2 and $HfSi_2$-HfB_2. Measurement of lattice parameter as influenced by composition.

Ryshkewitch, Eugene
METAL OXIDE CERAMICS. International Science and Technology: 54-61 (February 1962)

Ryshkewitch, Eugene
OXIDE CERAMICS – PHYSICAL CHEMISTRY AND TECHNOLOGY. Academic Press Inc., New York, 1960, 472p.

Samuels, L. E.
DAMAGED SURFACE LAYERS: METALS. Paper from SURFACE CHEMISTRY OF METALS AND SEMICONDUCTORS. John Wiley & Sons, Inc., New York, 1960, p. 82-106.

The nature of the physically altered layers of metal caused by cutting or polishing is reviewed, consideration being given to residual elastic stress, surface topography and accumulation of embedded abrasive in steel, bronze, brass, Cu, Sn, Zn, Mg, Ag, Al and Be. Distinction is made between plastically deformed layers and amorphous-like Beilby layers.

Savitsky, E. M. Oleg D. Sherby, Ed.
THE INFLUENCE OF TEMPERATURE ON THE MECHANICAL PROPERTIES OF METALS AND ALLOYS. Stanford University Press, Stanford, Calif., 1961, 303p.

Examination of mechanical properties and their relation to the internal structure of solids, mechanisms of plastic deformation, methods of mechanical testing and the application of mechanical tests in physicochemical analyses of metallic systems. Equipment and techniques for testing with emphasis on micromechanical-test apparatus and methods. Influence of temperature on the mechanical properties of monomorphic and polymorphic metals, metallic compounds, alloys in eutectic and solid-solution systems and alloys based on metallic compounds. Included are criteria for selecting optimum conditions for hot working alloys.

Sawkill, J. and J. E. Meredith
THE ETCHING OF SUB-STRUCTURES IN BERYLLIUM. Philosophical Magazine, v. 5: 1195-1196 (November 1960)

Aqueous solutions of $CuSo_4$, $AgNo_3$, or gold chloride are used to etch Be, the Cu, Ag or Au being deposited at the grain boundaries.

Sawkill, J. and R. Schwarzenberger
X-RAY MICROSCOPY OF BERYLLIUM. British Journal of Applied Physics, v. 11: 498-503 (November 1960)

The point-projection X-ray microscope has been used to study a variety of beryllium specimens, ranging from single crystals to finely-polycrystalline metal containing inclusions. The highly divergent beam of X-rays from a source 1 μ in diameter gives, on the same photograph, a microradiograph of the specimen with a resolution of 1 μ and a divergent beam diffraction pattern. Together these can give information about the distribution of heavier elements or cracks in the beryllium, the variation in perfection of the crystal lattice and, with a single crystal, the orientation and lattice parameters of the specimen.

Schonfeld, F. W.
PLUTONIUM PHASE DIAGRAMS STUDIED AT LOS ALAMOS. Chapter 22 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, 1961, p. 240-254.

Metallography, dilatometry, X-ray diffraction and thermal analysis data at 20-1800°C are reviewed with phase diagrams constructed for some of the binary systems of Pu with Al, Be, Bi, Co, Ni, Fe, Pb, Mg,

Mn, Ru, Th, U, W, Ta, Mo, Cb, Cr, V, Ce, Hg, Zn, As, Cu, Ge, Au, In, Pr, Nd, La, Re, Si, Ag, Sn, Ti, Zr, O and H.

Schonfeld, F. W.
PLUTONIUM PHASE DIAGRAMS PUBLISHED BY THE RUSSIANS. Chapter 23 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, 1961, p. 255-264.
Review of phase constitution analysis data for binary systems of Pu at 20-1800°C with diagrams constructed for alloys with Be, Fe, Mn, Ni, Os, V, Cr, Al, Be, Cu, Mo, Th, U and Zr.

Smith, R.
METALLOGRAPHIC OBSERVATIONS ON THE OXIDATION OF BERYLLIUM IN WET CARBON DIOXIDE. p. 147-56 of FUEL ELEMENT FABRICATION WITH SPECIAL EMPHASIS ON CLADDING MATERIALS. Vol. 2. London and New York Academic Press, 1961.
Investigation of the breakway phenomena when machines and etched surfaces of Be are oxidized in wet CO_2 at 700°C using metallographic and X-ray and electron diffraction techniques.

Sokolov, O. K.
COMPOUND FORMATION IN BINARY SULFIDE SYSTEMS. Izvestiya Akademii Nauk SSSR-Otdelenie Takhnicheskikh Nauk-Metallurgiya i Toplivo, no. 1: 54-55 (January-February 1962) (Russian)
Tabulated distances between cation and anion in sulfide crystals from which are made the prediction for formation of chemical compounds in double sulfide systems. Predicted and experimental compound formations are reported for twenty sulfide salt combinations.

Straumanis, M. E. and D. L. Mathis
THE DISINTEGRATION OF BERYLLIUM DURING ITS DISSOLUTION IN HYDROCHLORIC ACID. Less-Common Metals Journal, v. 4: 213-215 (April 1962)

Strauss, S. W.
FURTHER EVIDENCE FOR THE ATOMIC SIZE EFFECT IN DILUTE BINARY LIQUID METAL SOLUTIONS. Acta Metallurgica, v. 10: 171-172 (February 1962) (English)
Data are given for the atomic size factor in the absolute solubility and temperature coefficient relation for dilute binary metallic systems in which the phase in equilibrium with the solid solution is essentially pure solute in the concentration region considered. Atomic size factor values are given for solvents of Ag, Al, Be, Co, Fe, Ga, In, Li, Mg, Mn, Na, Ni, Pb, Sn and Zn and for solutes of Ni, Be, Pb, C, Cr, Fe, Be, Mo, Ti, Mn, U, Zr, Ag, Al, Co, Cu, Zn and Tl.

Teutonico, L. J.
MOVING EDGE DISLOCATIONS IN CUBIC AND HEXAGONAL MATERIALS. Physical Review, v. 125: 1530-1533 (March 1962)
The upper and lower limits of the velocity range for which edge dislocations display anomalous behavior are calculated for various cubic and hexagonal materials and for several orientations and directions of motion of the edge dislocation.

Thomas, Gareth
TRANSMISSION ELECTRON MICROSCOPY OF METALS. John Wiley & Sons, Inc., Philadelphia, 1962, 299p.
Theoretical and applied technology and equipment used with ferrous alloys, stainless steel and Cr, Au, Al, Cu, Mo, Ni, Ag, Pt, Mg, Co, Zn, Fe, Sn, Cb, Ti, V and Mn and their alloys. Electron scattering; image formation and contrast from crystals; the electron microscope; preparation of specimens; applications of thin foil techniques. Grain structure and diffraction patterns as influenced by temperature and heat treatment.

Thomas, Hans
INTERMEDIATE PHASES IN AGE HARDENING OF COPPER-BERYLLIUM ALLOYS. Zeitschrift fur Metallkunde, v. 52: 750-753 (November 1961) (German)

Throner, G. C. and I. Lieberman
STAMPINGS FOR THE SPACE AGE... BY EXPLOSIVE FORMING. Tool and Manufacturing Engineer, v. 46: 123-126 (May 1961)

Tseitlin, Kh. L., E. K. Revazov, and V. A. Strunkin
EFFECT OF THE CATHODIC POLARIZATION OF TANTALUM ON ITS ELECTRICAL CONDUCTIVITY. Zhur. Priklad Khim., v. 33: 850-4 (April 1960) (Russian)

Tukhinski, G. F., V. A. Funkel, V. M. Amonenko, and I. I. Papirov
ORIENTATION BERYLLIUM RESIDUE ON TEXTURAL AND ISOTROPIC LINING. Fizika Metallov i Metallovedenie, v. 12: 73-77 (January 1961) (Russian)
Study of texture during condensation in vacuum by X-ray analysis. Determination of molecular ray inclination angle.

Vainshtein, E. E., E. A. Zhurakovskii, and I. B. Staryi
AN X-RAY SPECTROSCOPIC STUDY OF TITANIUM BERYLLIDES. Academy of Sciences of the USSR Proceedings, Physical Chemistry Section, v. 135: 1077-1079 (November 1960)

Weik, H.
PLASTIC DEFORMATION OF BERYLLIUM. Metall, v. 15: 686-694 (July 1961) (German)
Crystal structure and plastic deformation mechanism of polycrystalline Be and Be single crystals. Means for improving workability and elimination of crack formation. Study of grain refinement, control of deformation texture and surface quality and methods for cladding and plating.

Westbrook, J. H. and D. L. Wood
EMBRITTLEMENT OF GRAIN BOUNDARIES BY EQUILIBRIUM SEGREGATION. Nature, v. 192: 1280-1281 (December 1961)
Investigation and tabulation of cases as iron, Al-bronze, beryllides, silicides and several intermetallics in which grain boundary hardening by equilibrium segregation is observed using microhardness measurements.

White, G. K.
THERMAL EXPANSION AT LOW TEMPERATURES. PT. 2. ELECTRONIC COMPONENT IN METALS. Philosophical Magazine, v. 6: 815-818 (June 1961)

Wick, Charles H.
EXPLOSIVE AND OTHER HIGH-ENERGY-RATE FORMING METHODS. Chapter 16 from CHIPLESS MACHINING. Industrial Press, New York, 1960, p. 435-485.

Williams, J. and J. W. S. Jones
THERMAL ETCHING OF BERYLLIUM. Journal of Nuclear Materials, v. 4: 234-235 (July 1961)
Changes of surface topography as a function of vacuum annealing time (30-120 min) at 900-975°C is investigated for polished specimens of cast electrolytic Be. Correlation of etch pit formation and distribution within the grains and at grain boundaries with dislocation sites on the surface.

Aircraft Production, v. 23: 303-307 (August 1961)
ELECTRON-BEAM WELDING.
Description, equipment and applications of process including typical setting for welding alloy steels, Cu, Ta, Be, Ti, Mo, Ni, Zr, Cd and Al alloy.

British Journal of Applied Physics, v. 12: 585-591 (November 1961)
CONFERENCE ON ELECTRON MICROSCOPY — NOTTINGHAM, JULY 1961.

Engineer, v. 212: 1018-1020 (December 1961)
PHASE-EQUILIBRIUM STUDIES IN METALLURGICAL SYSTEMS.
Differential thermal anlaysis, electron probe microanalysis and light microscopy are used to develop binary phase equilibrium diagrams for various combinations of Hg, Ag, Sn, Fe, Cr, Ni, Mo, Mn, V, Ru, Zn, Pt, Cu, Be and Au.

Magnesium Products: 8-9 (August 1961)
TITANIUM AND BERYLLIUM PROVE THEIR RELIABILITY IN THE MERCURY CAPSULES.
Rigidity and structural strength of Ti and Be capsules are tested under 20 G's pressure at 600-1200°F with examination of fusion, seam and spot welds.

Metal Treatment and Drop Forging, v. 29: 31-36 (January 1962)
PHASE-EQUILIBRIUM STUDIES.
Description of advanced techniques used at the U. S. National Bureau of Standards to obtain relevant data in their phase-equilibrium investigations of uranium and related groups, semiconductor metals, the Hg-Ag-Sn system and other systems. Principles of binary, ternary and higher systems; purification and refining techniques; test methods including thermal analysis, microscopy and electron-probe microanalysis.

Press Universitaires de France, 108 Boulevard Saint-Germain, Paris, France, 1961, 184p.
PROPERTIES OF GRAIN BOUNDARIES. (PROPRIETES DES JOINTS DE GRAINS).
Papers presented at the 4th Metallurgy Conference, June 27 and 28, 1960 at Saclay, France sponsored by the Center for Nuclear Studies. Topics include the effects of heat and mechanical treatments with resulting polygonization, precipitation, recrystallization, germination, diffusion, segregation and sliding processes, of mono, bi and polycrystals

of Al, Fe, Ni and alpha U, Al, Fe and Ni alloys, austenitic stainless steels, Al-Zn alloys and Al-Zn-Mg alloys of specified purity on grain boundary mobility, stability, embrittlement, coherency, intergranular cohesion and brittleness, point defects and other properties.

Reactor Core Materials, v. 3: 37-50 (August 1960)
CLADDING AND STRUCTURAL MATERIALS.
Corrosion resistance of Zr, Cb, Al stainless steel and Fe, Ni and Co alloys in nuclear applications. Mechanical properties of Zr, Cb stainless steel, W. Mg and Mg alloys. Effects of radiation on non-fuel materials.

Reactor Core Materials, v. 4: 19-25 (August 1961)
MODERATOR MATERIALS.

AAEC/E-80
Australia. Atomic Energy Commission Research Establishment. Lucas Heights, New South Wales
A COMPARATIVE STUDY OF TWO GRADES OF BeO. K. D. Reeve and E. J. Ramm. November 1961. 33p.

AD-255443
Convair Astronautics, San Diego, Calif.
A THEORETICAL DESIGN STUDY APPLYING BERYLLIUM TO STORABLE LIQUID PROPELLANT ROCKET TANKAGE. R. L. Jones and R. E. Carlson.

AD-258241
Nuclear Metals, Inc. (Wright Air Development Div.)
DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F. Yans. December 1960. 93p.

AD-258588
Reactive Metals Inc., Niles, Ohio
A STUDY OF THE EFFECT OF ELECTRON BEAM MELTING ON COMPOUNDS AND METALS. R. L. Martin, S. R. Seagle and O. Bertea.

AD-261382
Nottingham U. (Great Britain)
PHYSICAL AND CHEMICAL PROPERTIES OF ANHYDROUS NITRATES OF THE TRANSITION METALS. ANNUAL TECHNICAL REPORT JUNE 1, 1960-MAY 30, 1961. C. C. Addison. June 30, 1961. 24p. (Contract DA 91-591-EUC-1450).
Crystallographic study of the addition compounds of Cu and Bi nitrate with nitro-methane and dioxan.

AD-264988
Electro-Optical Systems, Inc., Pasadena, Calif.
INVESTIGATION OF THE EFFECT OF ULTRA RAPID QUENCHING ON METALLIC SYSTEMS, INCLUDING BERYLLIUM ALLOYS. PROGRESS REPORT NO. 2, JUNE 1-SEPTEMBER 30, 1961. C. B. Jordan. October 1961. 13p. (EOS rept. 1650-4M-2) (Contract AF 33 (616)8011, Proj. 1(8-7351))
Effect of ultra rapid quenching on the microstructure, phase transition and lattice parameter of Be-O, Be-Al, Be-Cu, Be-Si, Be-Sc, Be-Ni and Be-Zn, subjected to X-ray diffraction analysis.

AE-32

Aktiebolaget Atomenergi, Stockholm
STRUCTURE INVESTIGATIONS OF SOME BERYLLIUM MATERIALS.
I. Fäldt and G. Lagerberg. January 1960. 15p.

Metallographic structure, microhardness, and texture were studied on various types of Be materials. It was found that Be exhibited its highest hardness values in directions perpendicular to the basal plant (0001).

AERE-R-3769

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE BEHAVIOR OF IRRADIATED BERYLLIUM. R.S. Barnes. July 1961. 15p.

Explanation of the changes in mechanical properties and volume of Be which occur during fast neutron irradiation and subsequent heat treatment; interaction of He atoms which are formed with clusters of displaced atoms and vacancies.

APEX-633

General Electric Co. Flight Propulsion Lab. Dept., Cincinnati
EVALUATION OF BERYLLIUM AND URANIUM CROSS SECTIONS FOR NEUTRON DIFFUSION THEORY CALCULATIONS. F.G. Dawson. October 1958. 38p. (Contracts AF 33(600)-38062 and AT(11-1)-171)

APEX-637

General Electric Co. Flight Propulsion Lab. Dept., Cincinnati
URANIUM-BERYLLIUM-HYDROGEN SYSTEMS: AN EXPERIMENTAL STUDY. D.H. Fraembs. June 1961. 40p. (Contracts AF 33(600)-38062 and AT(11-1)-171)

Experimental determination of the reactivity of mixtures of water with U^{235} and mixture of BeO, H_2O and U^{235} using measurements made on subcritical and critical assemblies designed to determine optimum safe masses and atomic ratios of U, Be and H as applied to the ceramic production areas.

ASM-Paper-61-AV-13

American Society of Metals.
ADVANCED FABRICATION TECHNIQUES. R. Garcey, J. Glyman, and E. Green. 1961. 19p.

Explosive forming of Be.

CRGM-1041

Atomic Energy of Canada Ltd., Chalk River, Ont.
THE BEHAVIOUR OF HYDROGEN IN BERYLLIUM. C.E. Ells and W. Evans. August 1961. 11p.

Introduction of hydrogen into Be by proton irradiation and the subsequent behavior of the hydrogen on post-irradiation heating of the samples is observed by metallographic techniques. Observation of nucleation of hydrogen agglomerates and cracking along grain boundaries after heat treatment at 1000°C.

CW-R&DL-1

Canadian Westinghouse Co., Ltd., Hamilton, Ont.
ANNUAL PROGRESS REPORT ON THE BERYLLIUM RESEARCH PROJECT, 1959. W. D. Bennett. April 1960. 65p. (AECL-1029)

The work described consisted primarily of evaluating different grades of beryllium by metallographic and x-ray methods and carrying out a series of stress-rupture and tensile tests at high temperatures on the grades which showed some promise. Following these tests, metallographic studies were made on the fracture regions in a search for indications of grain-boundary void formation. Extruded 1/2-in.-diameter beryllium rod was received from two separate sources: Pechiney and Nuclear Metals.

DC-59-11-5

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati and Oak Ridge National Lab., Tenn.
THE RADIATION OXIDATION TESTING OF BERYLLIUM METAL SPECIMENS: TEST LTBM-1, TEST LTBM-2, TEST-3 (1957). R. C. Lee. October 1959. 18p. (Contract AT (11-1)-171)

Irradiation tests of Be bar stock at 1200°F.

DC-59-9-53

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
INVESTIGATION OF TWO INTERMETALLIC COMPOUNDS IN THE RHENIUM-BERYLLIUM SYSTEM-$ReBe_{16}$ AND $ReBe_2$. G. C. Huth and J. P. Smith. August 1959. 8p. (Contract AT (11-1)-171)

Evaluation of the oxidation resistance over 2000°F of $ReBe_{16}$ and $ReBe_2$ prepared in essentially single phase form, fabricated into billets by hot pressing in vacuum.

KAPL-1917

Knolls Atomic Power Lab., Schenectady, N. Y.
GRAIN REFINEMENT OF CAST BERYLLIUM. A. E. Bibb and S. M. Bishop. April 1958. 19p. Changed from OUO June 1960. (Contract W-31-109-eng-52)

Production of a fine equiaxed as-cast grain structure in beryllium or dilute beryllium-base alloy was investigated. A review of metal-casting theory was undertaken and a systematic investigation was made of the most promising grain-refining principles. It was found that the addition of ~2.5 wt % Al or Si produced a zone of equiaxed grains in Be ingots. Mechanical vibration was found to produce a refinement of the equiaxed zone. Additions of theoretically chosen nucleating agents further reduced the grain size of the equiaxed zone and the results indicated that with proper mixing a complete ingot could be produced which has a fine equiaxed structure. The resulting ingots could be machined and hot-rolled. Evidence of some ductility was found in both the cast and hot-rolled material. Further work is needed to exploit fully the potentiality of producing cast Be with properties comparable to those of hot-pressed powder.

LMSD-288139 (Vol. II)(Paper 13)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif. THE EFFECT OF RESIDUAL STRESSES ON THE CRITICAL CRACK LENGTH PREDICTED BY THE GRIFFITH THEORY. Paper 13 of GENERAL RESEARCH IN FLIGHT SCIENCES, JANUARY 1959-JANUARY 1960. VOLUME II. MECHANICS OF DEFORMABLE BODIES. W. E. Jahsman and F. A. Field. 23p.

The Griffith theory for unstable crack length is modified to take into account the effect of residual (self-equilibrating) stresses. An expression relating the uniform stress, physical properties of the material, critical crack length, and the equilibrating strain energy is derived for a general residual stress distribution. This expression is used to develop a criterion for spontaneous cracking due to residual stresses alone. A specific numerical example for a parabolic residual stress distribution in a beryllium plate is carried out in some detail.

LMSD-288140 (Vol. II)(Paper 3)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif. PLASTIC DEFORMATION IN BERYLLIUM. Paper 3 of GENERAL RESEARCH IN MATERIALS AND PROPULSION, JANUARY 1959 TO JANUARY 1960. VOLUME II. E. C. Burke. 17p.

The gross growth structure on electrodeposited beryllium crystals is rationalized on the basis of a Crova disk construction. Beryllium undergoes large amounts of accommodation kinking on the $\{1\ 1\ \overline{2}\ 0\}$ planes without cracking. Evidence is presented that beryllium may twin on planes other than $\{1\ 0\ \overline{1}\ 2\}$. The stereographic projection for beryllium is presented in a standard orientation.

MIT-1113 (Del.)

Massachusetts Inst. of Tech., Cambridge. Metallurgical Project. TECHNICAL PROGRESS REPORT FOR THE PERIOD APRIL 1953 THROUGH JUNE 1953. September 1953.

NAA-SR-5363

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.

CORROSION AND ACTIVITY TRANSFER IN THE SRE PRIMARY SODIUM SYSTEM. H. E. Johnson. October 1961. 42p. (Contract AT-11-1-GEN-8.

NAA-SR-6425

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.

BERYLLIUM OXIDE SINGLE CRYSTAL GROWTH. PT. 1. ALKALI MOLYBDATA METHOD. S. B. Austerman and A. R. Hopkins. January 1962. 40p. (Contract AT (11-1)-GEN-8)

Production of crystals up to 5 millimeters (imperfect) and two millimeters (clear, well-formed) by the growth of beryllium oxide in Li_2MoO_4-MoO_3. Data given for general behavior of the alkali molybdate-beryllium oxide system.

NDA-2162-1

Nuclear Development Corp. of America, White Plains, N. Y. and Carborundum Co., Niagara Falls, N. Y.
CARBIDE FUEL DEVELOPMENT. PROGRESS REPORT, PERIOD OF SEPTEMBER 15, 1960-JANUARY 31, 1960. A. Strasser and K. Taylor. February 1961.

Addition of Ni to UC batches synthesized in a graphite resistance furnace to lower the sintering temperature. Specimens are in contact with cladding materials of Inconel X, 304 stainless steel, 2-1/4 Cr-Mo, Be and Zircaloy 2 at 820°C in an He atmosphere. Compatibility and thermal conductivity are measured for irradiated samples.

NMI-207 (Del.)

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR JULY 1 THROUGH OCTOBER 31, 1958. November 1958.

Investigation of Be metallurgy including activation analyses for oxygen, cladding for uranium fuel elements and random orientation in wrought Be and its alloys. Uranium metallurgical studies of high strength cladding for fuels, inter-diffusion heat treatment and hollow fuel pins. Developments in Zr metallurgy including high temperature corrosion-resistant alloys, cladding and tubing textures and ribbed tubing. Investigation of extrusion bonding, shift and whiskers in co-extruded rods and tubes; yttrium fabrication.

NMI-1218

Nuclear Metals, Inc., Concord, Mass.
STABILITY OF THE HIGH TEMPERATURE BETA PHASE IN BERYLLIUM AND BERYLLIUM ALLOYS. S. H. Gelles and J. J. Pickett. October 1960. 44p. (Contract AT(30-1)-1565)

NMI-1252

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY; STABILITY OF THE HIGH TEMPERATURE BETA PHASE IN BERYLLIUM AND BERYLLIUM ALLOYS. FINAL TECHNICAL REPORT, JULY 1, 1960 THROUGH JUNE 30, 1961. J. J. Pickett, E. D. Levine, and W. B. Nowak. September 1961. 34p.

The equilibrium phase boundaries are determined by differential thermal analysis for Be alloys in each of the following systems: Ba, Ce, Co, Cu, La, Mn, Pt, Ag, Ni-Co, Ni-Fe, Ni-Cu, Ni-Co-Fe and Ni-Co-Mn. Correlation between the beta-alpha upper solvus transition temperature and the electron-to-atom ratios for alloys of Be with Co, Cu, Fe and Ni. Tensile testing to determine the area reduction of unalloyed Be and a Be-8 at. % Ni alloy.

NMI-2097

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT TO THE UNITED STATES ATOMIC ENERGY COMMISSION FOR JULY 1961. October 1961. 24p. (Contract AT(30-1)-1565.)

High temperature properties of the refractory alloys Mo-Hf, W-Hf, W-Ru and Cb-Re; fundamentals of Zr alloy corrosion; the incorporation

of metal ions into ZrO_2 lattices; irradiation behavior of metastable beta U; and the fundamentals of single crystal deformation in zone-refined Be.

NMI-2100

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT, OCTOBER 1-OCTOBER 31, 1961. January 1962. 15p. (Contract AT(30-1)-2784)

Study of high temperature properties of refractory metal alloys, corrosion of Zr alloys, irradiation behavior of metastable beta-phase uranium, and monocrystal deformation in zone-refined Be.

NMI-2101

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT, NOVEMBER 1961. January 1962. 14p. (Contract AT(30-1)-2784)

NMI-9605

Nuclear Metals, Inc., Concord, Mass.
SECOND QUARTERLY REPORT TO WRIGHT AIR DEVELOPMENT DIVISION DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F. M. Yans, A. K. Wolff, and A. R. Kaufmann. May 1960. 28p. (Contract AF 33(616)-6616)

NMI-9608

Nuclear Metals, Inc., Concord, Mass.
DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. THIRD QUARTERLY REPORT TO WRIGHT AIR DEVELOPMENT DIVISION. F. M. Yans, A. K. Wolff, and A. R. Kaufmann. May 1960. 17p. (Contract AF 33(616)-6616)

NP-8911

Beryllium Corp., Reading, Penna.
BERYLLIUM CASTING. PHASE II. INTERIM TECHNICAL REPORT NO. 7 FOR MARCH 18, 1960-JUNE 17, 1960. Paul M. Cohen and R. C. Harris. 29p. (ASC Project 7-643) (Contract AF 33(600)37902)

NP-9819

Franklin Inst. Labs. for Research and Development, Philadelphia
PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. BI-MONTHLY PROGRESS REPORT, JANUARY 2-MARCH 1, 1961. G. E. Spangler and M. Herman. 5p. (P-A2476-1) (Contract NOw-61-0221-d)

NP-9871

Franklin Inst. Labs. for Research and Development, Philadelphia
THE PREPARATION OF HIGH PURITY BERYLLIUM AND THE STUDY OF ITS FLOW AND FRACTURE PROPERTIES. FINAL REPORT, JUNE 30, 1959 TO JUNE 30, 1960. Marvin Herman, G. E. Spangler, and Edward Hein. 26p. (F-A2323) (Contract NOas 59-6242-c)

Several beryllium single crystals were prepared by the floating zone method of zone melting. These crystals, tested in tension, exhibited extensive basal plane glide prior to fracture. These observations represent a significant increase in ductility in comparison to previously reported work. The increased ductility of the zone-melted

crystals is discussed with respect to the purification attained and also with respect to the role of impurities in the presently proposed fracture mechanisms of beryllium.

NP-10284

Franklin Inst. Labs, for Research and Development, Philadelphia
PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM.
G. E. Spangler and M. Herman.

Determination of ultimate ductility and critical resolved shear stress for basal glide as a function of impurity level in elongated, zone melted single crystals.

NP-10346

Beryllium Corp., Reading, Pa.
DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. THIRD INTERIM REPORT FOR PERIOD JANUARY 29, 1961 TO APRIL 28, 1961. FINAL PHASE II REPORT.
K. C. Taher and E. E. Weismantel. 83p. (Contract AF 33(600)-41959-3)

NP-10411

Aluminum Co. of America. Alcoa Research Labs., New Kensington, Penna.
ALUMINUM BINARY EQUILIBRIUM DIAGRAMS. E. H. Wright and L. A. Willey. 1960.

Phase diagrams are given for the binary Al alloys of: Ag, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, Ga, Ge, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Ni, Pb, Pd, Pr, Pt, Pu, S, Sb, Se, Si, Sn, Ta, Te, Th, Ti, Tl, U, V, W, Zn and Zr. Tables are included giving the solid solubilities of elements in Al and the properties of intermetallic compounds of Al binary alloys.

NP-10859

Franklin Inst. Labs for Research and Development, Philadelphia
PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. BI-MONTHLY PROGRESS REPORT, JULY 2-SEPTEMBER 1, 1961.
G. E. Spangler, E. J. Arndt, and M. Herman. 12p. (Contract NOw-61-0221-d) (P-A2476-5)

NP-11072

Beryllium Corp., Reading, Penna.
BERYLLIUM CASTING. INTERIM TECHNICAL ENGINEERING REPORT NO. 10, REPORTING PERIOD, JULY 5-NOVEMBER 4, 1961. B. H. Hessler and J. P. Denny. 27p. (Contract AF 33(600)-37902)

NYO-9187

Nuclear Materials and Equipment Corp., Apollo, Penna.
FINAL REPORT ON CORROSION AND RADIATION DAMAGE RESISTANT FUEL MATERIAL, NOVEMBER 15, 1959 THROUGH NOVEMBER 14, 1960.
130p. (Contract AT-(30-1)-2264)

Patent - U.S. 3,026,200

METHOD OF INTRODUCING HARD PHASES INTO METALLIC MATRICES. Eric Gregory. March 20, 1962.

Production of slip inhibiting phases in uniform dispersion in metal matrices by an internal oxidation process in which oxygen is diffused through the powdered metal to produce refractory oxides.

TID-7603

U. S. Atomic Energy Commission
CARBIDE FUEL DEVELOPMENT AT NUCLEAR DEVELOPMENT CORP OF AMERICA. Paper from URANIUM CARBIDE MEETING, PROCEEDINGS. A. Strasser. 1960. p. 93-106.

Metallographic evaluation of enriched UC pellets. Compatibility of 304 stainless steel, 2.25% Cr-1% Mo alloy steel, Inconel-X, Cb-2 and Be with UC is studied at 820°C. Specimen capsule for irradiation study. Raw material costs are surveyed and tabulated.

TID-7610 (p. 104-112)

General Atomic Div., General Dynamics Corp., San Diego, Calif.
THE DIMENSIONAL STABILITY OF IRRADIATION OF Al_2O_3-UC_2. Dale E. Johnson and J. Martin Tobin.

Metallographic study of the breakage, dimensional stability, density, radiation damage and fission gas release of clad, diluted fuel pellets.

TID-7610 (p. 147-156)

Oak Ridge National Lab., Tenn.
PHASE BEHAVIOR OF MOLTEN FLUORIDE FUELS, BLANKETS AND COOLANTS. R. E. Thoma, H. Insley and H. A. Friedman.

Phase diagrams are given for polycomponent systems containing LiF, BeF_2, UF_4 and ThF_4.

TID-10059 (Del.)

Ames Lab., Ames, Iowa
PROCEEDINGS OF THE SPRING METALLURGY CONFERENCE, HELD AT AMES, IOWA, MARCH 24-26, 1952. VOL. 2. June 1952.

TID-14955

Denver. Univ. Denver Research Inst.
INTERMEDIATE-TEMPERATURE OXIDATION OF BERYLLIDES. MONTHLY LETTER REPORT NO. 5, JANUARY 1-FEBRUARY 1, 1962. Frank C. Perkins. February 1962. 4p. (Contract AT(11-1)-1092)

Oxidation studies include: determination of a weight-gain vs time curve for 1600°C isothermal annealing of Cb_2Be_{17} in oxygen, argon and moist air; and metallographic and X-ray diffraction studies of the surface mechanisms of catastrophic oxidation.

UCRL-Trans-740 (L)

THE MODIFICATIONS OF BORON. EXPERIMENTS ON THE INCORPORATION OF BERYLLIUM IN THE BORON LATTICE. H. J. Becher and A. Schaefer. Translated from Z. anorg. u. allgem. Chem., 306: 260-5 (1960). 8p.

Boron crystals incorporating Be are prepared by the mutual decomposition of BBr_3 and $BeBr_2$ on a heated Ta filament. Crystal structure and cell dimensions are determined by spectrographic studies.

UK-10

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
EUROPEAN ATOMIC ENERGY SOCIETY – STOCKHOLM 1959 – THE EFFECT OF IRRADIATION UPON BERYLLIUM. Robert S. Barnes. 3p.

Beryllium undergoes two nuclear reactions with fast neutrons. The effects on the material become more important at high doses and operating temperatures. A discussion of these effects is presented with brief reference to those of the normal atomic displacements.

WADC-TR-59-500

Illinois Inst. of Tech., Chicago. Armour Research Foundation
BERYLLIUM RESEARCH FOR DEVELOPMENT IN THE AREA OF CASTING. PERIOD COVERED JUNE 15, 1958 TO OCTOBER 14, 1959. Frank A. Crossley, Arthur G. Metcalfe, and William H. Graft. July 31, 1959. 102p. (Project Nos. 7021 and 7351. Contract AF 33(616) -5911)

Various aspects of the casting of beryllium have been investigated as follows: (1) X-ray determination of the direction of columnar growth in cast beryllium; (2) consumable arc melting; (3) reported allotropy by thermal analysis; (4) grain-refining inoculants; and (5) application of vibration to cast beryllium for grain refinement. A very pronounced thermal arrest was found 5 to 10°C below the solidification temperature. Also, transformation markings were observed metallographically. No preferred orientation of columnar grains was found. Consumable arc-melting experiments showed grain size from 316 grains/in^2 to 616 grains/in^2. Rust-colored tantalum nitride, WC, and TiB_2 apparently nucleated beryllium solidification to produce grain refinement. Also, an alloying addition of 1 at. % Ge produced grain refinement.

WADD-TR-60-403

Nuclear Metals, Inc., Concord, Mass.
DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F.M. Yans, A.K. Wolff, and A.R. Kaufmann. September 1960.

WADD-TR-60-404

Reactive Metals, Inc., Niles, Ohio
A STUDY OF THE EFFECT OF ELECTRON BEAM MELTING ON COMPOUNDS AND METALS. R.L. Martin, S.R. Seagle and O. Bertea. July 1960.

Investigation of mechanical properties, microstructure and phase transition for B, B-C and B-Si alloys, TaC, TiC, zirconium di-boride, Be, Hf, Co, W, V and Mo and their interstitial elements.

WADD-TR-61-123

Research Chemicals Div. of Nuclear Corp. of America, Burbank, Calif.
PROPERTIES OF YTTRIUM AND THE RARE EARTH METALS OXYGEN AND ALLOY SYSTEMS. OXYGEN AND ALLOY SYSTEMS. Bernard Love. February 1961. 79p. (Contract AF 33(616)-6829)

Determination of partial constitutional diagrams and atmospheric corrosion rates, for Y-Er, Ta-La, Ta-Er, Ta-Y, Cb-Er and Cb-Y systems. Solubility of oxygen in Y, Er, Nd and Sm systems with oxygen at 1000°C. Determination of the alphs to beta transformation temperature for Sm and Nd. Effects of metal purity on the melting and transformation temperatures.

SECTION V. BERYLLIUM METALLURGY

PART L. TRANSFORMATIONS AND RESULTING STRUCTURES

Adgate, F. N.
A METHOD OF DETERMINING PRIMARY SOLID SOLUBILITY OF AN ALLOY. Welding Journal, v. 40: 196s, 222s (May 1961)
Tentative method of predicting solid solubility of an alloy from size factor of the atoms, electrochemical compounds and valency factors of the components. Atomic diameters and electrochemical factors of common metallic elements.

Amonenko, V. M., V. E. Ivanov, G. F. Tikhinskii, V. A. Finkel and I. V. Shpagin
HIGH TEMPERATURE POLYMORPHISM OF Be. Fizika Metallov i Metallovedenie, v. 12: 865-872 (June 1961) (Russian)
99.9% pure Be containing oxygen carbon and impurities is investigated for the phase transformation of the compact hexagonal lattice alpha-Be into a volume centered cubic lattice beta-Be. Influence of temperature and impurities on the electrical resistance, lattice parameters, coefficient of the thermal expansion and specific volume method of specimen preparation.

Arbiter, W. and G. Stern
SOME ASPECTS OF DISPERSION HARDENING IN THE URANIUM-URANIUM OXIDE SYSTEM. Planseeberichte fur Pulvermetallurgie, v. 9: 113-121 (Apr. 1961) (English)
Fabrication technique; microstructure investigation; hot (1500°F) indentation hardness, hot (1560-1750°F) bending and thermal cycling (1130-1350°F) tests for a dispersion hardened material of near theoretical density (called SUP), which is obtained by controlled surface oxidation of fine uranium particles followed by hot (1500-1700°F) pressing and extrusion.

Bastien, P. and P. Pointu
MODES OF DEFORMATION OF BERYLLIUM AT HIGH TEMPERATURE AND RECRYSTALLIZATION AFTER TWINNING. Journal of Nuclear Materials, v. 5: 153-155 (Jan. 1962) (French)

Blair, J. S.
PHOTODISINTEGRATION OF BE^9. Physical Review, v. 123: 2151-2153 (Sept. 1961)
The reaction Be^9 (gamma ray, neutron) Be^8 is discussed for those transitions in which the odd neutron goes from an initial p state to an "s" state in the continuum. The model accounts for the increases in cross section observed at an excitation energy of 4.6 Mev., the isotropic distribution of the neutrons associated with this rise and the ratio of the integrated cross section for this rise to that for the threshold peak.

Bohm, Horst
PRECIPITATION CHARACTERISTICS OF BINEARY COPPER ALLOYS AS INFLUENCE BY ADDITIONS OF A THIRD ELEMENT. Zeitschrift fur Metallkunde, v. 52: 564-571 (Sept. 1961) (German)

Investigation of continuous and discontinuous precipitation, after homogenizing at 600-750°C, in binary alloys of Cu with 1.5-2.5% Mg, 35-55% Mn, 0.8-1.5% P, 5-10% Sb and 15% Sn, with and without additions of 0.5 at. % Fe, Si, Be, In, Mg and Sb, respectively, by microstructure examination and hardness measurements.

Buckley, S. N.
IRRADIATION GROWTH. Paper from PROPERTIES OF REACTOR MATERIALS AND THE EFFECTS OF RADIATION DAMAGE. Butterworths, London, 1962, p. 413-429.

Effect of irradiation at -196 and 75°C, plastic deformation and alloying elements on anisotropic growth rate of single crystal and polycrystalline alpha uranium and in non-fissile metals, including Zn, Zr, Ti and Cd. Examination of Be, Mg and the cubic metals in terms of previous theories.

Calais, Daniel
STRUCTURAL MODIFICATIONS OF METALS AND ALLOYS BY IRRADIATION. Metaux Corrosion-Industries, v. 36: 70-84 (February 1961) (French)

Irradiation at -150 to 2000°C of white tin, CuFe, ZrO_2, UMo, P, $BaTiO_3$, U_2Mo, Ni_3Mn, Cu_3Au, NiBe, CuBe, austenitic steel, inox steel and alpha and beta brass. Changes in microstructure and density of the solid alloys and metals with resulting fission chain reactions, homogenization, allotropic and order-disorder transformations, ionization and phase precipitation processes.

Chang, R. (Atomics International, Canoga Park, Calif.)
THE ELASTIC AND ANELASTIC PROPERTIES OF REFRACTORY MATERIALS FOR HIGH-TEMPERATURE APPLICATIONS. p. 209-20 of MECHANICAL PROPERTIES OF ENGINEERING CERAMICS. New York, Interscience Publishers, 1961.

Analysis of anelastic phenomena associated with grain boundary relaxation, twin interface motion and dislocation motion in aluminum oxide, beryllium oxide, magnesium oxide, zirconium hydride, zirconium oxide, CbBe and graphite crystals.

Chollet, M. L.
ELECTRICAL RESISTANCE AND METALLOGRAPHY. Microtecnic, v. 15: 203-207 (October 1961)

Coffinberry, A. S.
LATER PLUTONIUM METALLURGICAL RESEARCH AT LOS ALAMOS. Chapter 5 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Illinois, 1961, p. 36-62.

Crossley, F. A., A. G. Metcalfe, and R. P. Elliot
ORIENTATION OF CAST BERYLLIUM. Metallurgical Society of AIME, Transactions, v. 221: 890 (August 1961)

DeSaussure, G.
A NOTE ON THE MEASUREMENT OF DIFFUSION PARAMETERS BY THE PULSED-NEUTRON SOURCE TECHNIQUE. Nuclear Science and Engineering, v. 12: 433-435 (March 1962)

Reasons are given for the observed discrepancies between various measurements of decay constants. Crystalline moderators considered are Be, graphite and Be oxide.

Dostrovsky, I., Z. Fraenkel, and J. Hudis
FORMATION OF N^{13} IN HIGH ENERGY NUCLEAR REACTIONS. Physical Review, v. 123: 1452-1458 (Aug. 1961)

Evans, Doris
EARLY AGING EFFECTS IN COPPER-1.76% BERYLLIUM SINGLE CRYSTALS. Paper from ADVANCES IN X-RAY ANALYSIS. v. 1. Plenum Press, Inc., New York, N. Y., 1960, p. 143-162.

Gorelik, S. S., E. N. Spektor and S. N. Minkina
INVESTIGATION OF THE RECRYSTALLIZATION TEMPERATURE OF BI-METALLIC NICKEL ALLOYS. Izvestiya VUZ-Chernaya Metallurgiya, 138-147 (Mar. 1961) (Russian)

Investigation of Ni-Be, Ni-Cu, Ni-Al systems where Be, Cu and Al have smaller atomic radii than Ni, to find the influence of this difference on the temperature of recrystallization, the influence of the diffusibility of the added elements on the cohesive forces of the alloy and the influence of small additions of Cr on the temperature of recrystallization.

Hanna, G. L.
SOLID STATE REACTIONS BETWEEN NUCLEAR FUEL MATERIALS. Australian Institute of Metals, Journal, v. 7: p. 1 (Feb. 1962)

In nuclear fuel elements, where different materials are in intimate contact, solid-state reactions can limit both the life and operating temperature of the element. Examples of this type of compatibility problem are described together with factors which determine the reaction rates and the structure of the reaction zones produced.

Herpin, A. and D. Saint James (Center d'Etudes Nucleaires, Saclay, France)
DIFFUSION LENGTH OF A CRYSTALLINE POWDER, AND DISTORTION OF THE MAXWELL SPECTRUM. J. phys. radium, 22: 193-203 (Apr. 1961)(CEA-1730) (French)

Indirect determination of the absorption cross section from calculations of the diffusion length in crystals of Be and BeO.

Heubner, U.
OCCURRANCE OF PLATE-SHAPED SEGREGATION ZONES IN METAL ALLOYS. Metall, v. 16: 403-407 (May 1962) (German)

Review of knowledge of structure and growth mechanism of plate shaped segregation zones in alloys including the following systems: Al-Cu, Cu-Be, Al-Ag, Al-Zn, Cu-Fe-Ni, Cu-Ti, Au-Pt, Cu-Ni-Co, Ni-Al, Ni-Ti, Ni-Al-Ti, Ni-Cr-Cu, Ni-Mo-Si and Co-Ti.

Hickman, B. S., T. M. Sabine and R. A. Coyle
X-RAY DIFFRACTION STUDIES OF IRRADIATED BERYLLIUM OXIDE. Journal of Nuclear Materials, v. 6: no. 2, 190-198 (July 1962)

Hoffman, J. A., G. R. Baxter, R. C. Bertossa and B. R. Cottrell.
DIFFUSION BONDING BERYLLIUM COPPER FOR ULTRA HIGH-STRENGTH JOINTS. Welding Journal, v. 41: 160s-166s (Apr. 1962)

Hollis, W. S.
CRYSTAL FILAMENTS. Production Engineer, v. 40: 611-661 (Sept. 1961)

Growth mechanisms for crystal filaments of pure single crystal and metal whiskers (Fe, Cu, Be, Si, Sn, W, Ag, Cd, Zn) are explained by the presence of irregularities in the atomic structure of dislocations. Stress-strain patterns and relative strength of filament and bulk materials are given.

Hollis, W. S.
WHISKERS - A FABRICATING MEDIUM OF THE FUTURE? Metalworking Production, v. 106: 71-73, 75 (June, 1962)
Production of whiskers using Fe, Cu, Be, alumina, graphite, Si, SiC, Sn and boron carbide by electrolytic deposition, vacuum heating under Hg pressure at 700-1100°C., vapor condensation and hot dipping. Effect of atomic structure dislocations on whisker strength and influence of screw-dislocations on growth rate. Effect of strain on stress.

Hume-Rothery, W.
THE EFFECT OF ELECTRONEGATIVITY ON SOLID AND LIQUID MISCIBILITY. Journal of Less Common Metals, v. 4: no. 4, 390-392 (Aug. 1962)
Criticism of a method for predicting the solid solution formation among metals using an electronegativity-atomic radius diagram. The criteria for this method are violated by Ag, Cu, Ni, Hg, Cd, Zn, In and Mg in the solvent Au; Au, Mg and Li in Ag; Au and In in Cu, and Tl and Cd in Mg.

Jacquet, Pierre A.
NON-DESTRUCTIVE METALLOGRAPHY OF Al, Mg, Be AND THEIR ALLOYS. Revue de L'Aluminum, v. 37: 977-987 (Sept. 1960) (French)
Local electrolytic polishing and etching of semiproducts using a plug of cotton or fabric containing the electrolyte, a current being passed through the semiproduct and the electrolyte during application.

King, R. and A. P. Grunaugh
ELECTRICAL MEASUREMENTS. Paper from THE PHYSICAL EXAMINATION OF METALS. Edward Arnold, Ltd., London, England. 1960, p. 81-167

Komatsu, Noboru, Laszlo J. Bonis and Nicholas J. Grant
SOME FEATURES OF INTERNAL OXIDATION OF DILUTE COPPER AND NICKEL ALLOYS FOR DISPERSION STRENGTHENING. Paper from POWDER METALLURGY, Metallurgical Society of AIME. Interscience Publishers, Inc., New York 1, 1961, p. 343-358.
In applying internal oxidation as a means of producing dispersion-hardened metal-metal oxide alloys, it is preferable to accomplish this with the alloy in fine powdered form. Problems involved include powder size and shape, maximum solute content, oxide particle size as a function of temperature, time, distance of penetration and solute type.

Komjathy, S.
THE CONSTITUTION OF SOME VANADIUM-BASE BINARY AND TERNARY SYSTEMS AND THE AGEING CHARACTERISTICS OF SELECTED TERNARY ALLOYS. Journal of the Less-Common Metals, v. 3: 468-488 (Dec. 1961)

Kurfman, V. B.
NUCLEATION CATALYSIS BY CARBON ADDITIONS TO MAGNESIUM ALLOYS. Metallurgical Society of AIME, Transactions, v. 221: 540-546 (June 1961)

Grain refinement of Mg-Al melts by carbonaceous additions is attributed to nucleation by Al carbide. The effects of process and alloy variables are interpreted and predicted in terms of the dispersion and chemistry of this phase. Grain coarsening action is evaluated of Be, Zr, Ti and rare earth additions and for chlorination, temperature extremes and prolonged holding times.

Lazarev, B. G., E. E. Semenenko and A. I. Sudovtsov
MODIFICATIONS OF BERYLLIUM AND IRON IN FILMS CONDENSED ONTO COLD SUBSTRATES. Soviet Physics - JETP, v. 13: 75-77 (Translation-AIP) (July 1961)

Study of the electrical resistance of films of Be, Fe and Cu condensed onto substrates cooled with liquid He, H or N as a function of temperature. Two low-temperature modifications are discovered for Be films. A polymorphic transition is found for Fe films at 40°K but no polymorphic transitions are found for Cu.

Lenel, F. V. and G. S. Ansell.
A THEORY OF DISPERSION STRENGTHENING. Paper from POWDER METALLURGY. Metallurgical Society of AIME. Interscience Publishers, Inc., New York 1, 1961, p. 267-307

Dispersion strengthening is explained by utilizing two methods. The first, a theoretical approach, predicts the yielding and creep behavior of these alloys on the basis of dislocation theory. The second, an experimental approach, shows the variation of the yield and creep strength of these alloys with both the testing conditions and the structural parameters of these alloys. The combination of these two approaches leads to a fundamental understanding of the mechanism involved.

Leszynsk, Werner
FOURTH INTERNATIONAL PLANSEE SEMINAR (Held at Tyrol, Austria, on June 20-24, 1961) Journal of Metals, v. 13: 746-751 (Oct. 1961)

Lindsay, H. M., V. D. Scott and A. Moore
SELECTIVE DECORATION OF FINE STRUCTURAL EFFECTS IN BERYLLIUM. Less-Common Metals, Journal, v. 3: 407-411 (Oct. 1961)

A new chemical method has been developed to reveal submicroscopic structural effects in Be such as Fe-rich precipitates developed during aging. The method involves an ion-exchange reaction in which Cu decorates localized regions in the metal.

Maeda, Shinpei
ALUMINUM ALLOY RECRYSTALLIZING AT ROOM TEMPERATURE. Light Metals, v. 11: 17-31 (July 1961) (Japanese)

Small amounts of Ca (0.05-1.86%) are added to commercially pure Al, which usually recrystallizes at 300°C., to produce an alloy which recrystallizes at lower than room temperature and has good workability, high conductivity and corrosion resistance and softness

properties conducive to fabrication into collapsible tubes and sheathing materials by cold rolling after various soaking and annealing heat treatments. The calcium aids in purifying the alloy, the purification process also being enhanced by addition of small amounts of Ni, Sn, Fe, Be, Sr and B.

Martin, D. G.
THE INFLUENCE OF IMPURITY ATOMS ON THE ANNEALING KINETICS OF ELECTRON IRRADIATED COPPER. Philosophical Magazine, v. 6: 839-846 (July 1961)
Spectroscopically pure Cu and dilute Cu alloys containing 0.05% of Ag, Cd and Be are irradiated with 4 Mev electrons at -196°C and annealed at temperatures up to 50°C. The recovery of the irradiation damage is measured by changes in electrical resistance, measured in liquid helium. Annealing peaks are observed in pure Cu and in the dilute alloys as a function of temperature.

Morinaga, Takuichi, Takeo Goto and Tsuneo Takahasbi
ANOMALOUS SOFTENING AND STRUCTURE CHANGE OF CU-2% Be ALLOYS DUE TO DISCONTINUOUS PRECIPITATION. Japan Institute of Metals, Journal, v. 24: 777-781 (December 1960) (Japanese)
Hardness changes with aging times at 310°C after solution treatment at 760-810°C is observed in commercial Cu-Be alloys of similar composition by microscopy with examination of discontinuous precipitation by electron micrography. Overaging is related to initial hardening rate, subsequent softening anomaly, grain boundary and matrix nodule formation and spheroidization.

Ohta, Keizo and Yoshikazu Kobayashi
MAGNETIC PROPERTIES OF THE IRON-BERYLLIUM COMPOUNDS WITH THE HEXAGONAL STRUCTURE. Kobayasi Institute of Physical Research, Bulletin, v. 11: 61-64 (July-September 1961) (Japanese)
Preparation of polycrystalline specimen (beta-phase) Fe-Be compounds with 71.0 and 68.0 at. % of Be in vacuum induction furnace. Data are given for crystallographic and magnetic properties and magnetic anisotropy. Included are temperature levels in K°, Curie temperature, C° and liquid O level and the system phase diagram.

Palatnik, L. S. and N. T. Gladkikh
MICROHETEROGENEITIES OF THE VACUUM CONDENSATION OF METALLIC VAPORS. Doklady Akademii Nauk SSSR, v. 140: 567-570 (March 1961) (Russian)

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EFFECT OF THE CATHODIC POLARIZATION OF TANTALUM ON ITS ELECTRICAL CONDUCTIVITY. Zhur. Priklad, Khim, 33: 850-4 (Apr. 1960) (Russian)

It was found previously that cathodic polarization of Ta is accompanied by hydrogen up-take, causing ultimately cracking. Determination of the change of the electrical resistance presents a convenient method for measuring the amount of H_2 absorbed during the polarization process, allowing a prediction of the level of undesirable mechanical properties. Ta sheets containing about 1% Nb were used as cathode, a graphite rod as anode, and a 20% HCl solution as electrolyte in an electrolytic apparatus using current densities ranging from 0.1 to 10 amp/m^2. The resistance of Ta was found to increase directly with the amount of absorbed H_2. Increasing the cathode thickness from 1 to 5 mm required considerably longer periods of time to saturate it completely. Cracking of the metal is imminent when its specific resistance increases by 20 to 40% at 20° and by 90 to 110% at 60°C over its original value.

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THERMAL EXPANSION AT LOW TEMPERATURES. PT. 2. ELECTRONIC COMPONENT IN METALS. Philosophical Magazine, v. 6: 815-818 (June 1961)

Values are given for the linear and lattice components of thermal expansion as related to electronic specific heat and for the Gruneisen constant of Cu, Al, Pd, Fe, Cr and Be specimens below 10-12°K. Electron band structures, Fermi energy and density-of-state relations are drawn for the expansion coefficient.

White, G. K.
MEASUREMENT OF THERMAL EXPANSION AT LOW TEMPERATURE. Cryogenics, v. 1: 151-158 (March 1961)

Determination of the linear thermal expansion of Cu, Fe, Be and Cr at 4-300°K using a three-terminal capacitor to measure very small length changes. Design consideration for transformer bridge, reference capacitor, expansion capacitor and associated cryogenic problems.

White, G. K.
THERMAL EXPANSION OF SOLIDS AT LOW TEMPERATURES. Paper from "Seventh International Conference on Low Temperature Physics, Proceedings". University of Toronto Press, Canada, 1961, p. 685-688.

Capacitance measurements from 1.5-10°K on Be specimen cylinders in OFHC Cu cells. Thermal and electronic expansion coefficients and Gruneisen anharmonicity parameters are determined with data given for Al, Fe and Pb.

Wigotsky, Victor W.
'MATCHED' MATERIALS AND MOVING COPPER CONDUCTORS IMPROVE GYRO PRECISION. Design News, v. 16: 12-13 (September 1961)

Williams, L. R. and Eyre, P. B. (United Kingdom Atomic Energy Authority, Springfields, Lancs, England)
BERYLLIUM. p. 269-318 of MATERIALS FOR NUCLEAR ENGINEERS. A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

The applications of beryllium in reactors are briefly described; its advantages for canning are low absorption of thermal neutrons and high strength-to-weight ratio. Its occurrence and extraction are reviewed. The compositions of beryllium produced by electrolytic reduction of the chloride and by magnesium reduction of the fluoride are compared. Preparation of super-pure beryllium is discussed. The physical and nuclear properties of beryllium are briefly described. Fabrication is treated in some detail: casting, melting, powder metallurgy, working, and joining. The mechanical properties of beryllium are then reviewed. The use of beryllium to can uranium metal is discussed. Data on the compatibility of beryllium with air,

hydrogen, CO_2, water, liquid metals, and solids are reviewed. The toxic effects of beryllium and prevention of beryllium poisoning are considered. The status of beryllium as a reactor material is summarized.

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British Journal of Applied Physics, v. 12, Nov. 1961, p. 585-591.
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Summary of papers given on electron microscopic, electron diffraction and field ion microscopic investigations of surface properties of alloys of Au with Co, U. brass, aluminum oxide, nitrided steel, Au, Cu with Be and Sb, Al with Cu, low alloy steel, Cu with Ni 18/10 stainless steel, Cu-Sb and MgO. Investigations of aging in Fe-C and Fe-N alloys and ion etching of foils of Au and Al at low temperature and after annealing at 1200°C. Points of W, Mo and Ni are studied with a field ion microscope and pellets of Pt in C, Ir and Pt-Ir alloys pellets are prepared by sintering. 51 ref.

Bureau of Ships Journal, July 1962, p. 3-6
METALLURGICAL MATERIALS PROBLEMS. Pt. 1.

Canadian Chemical Processing, v. 45, Oct. 1961, p. 68-80.
MINING AND METALLURGY AT LAKE BERNIC – CHEMALLOY MINES THEM MEDIUM RARE.

Iron Age, v. 188, Aug. 1961, p. 72-73.
BREAKTHROUGH IN NUCLEAR FUEL UNSHACKLES REACTOR DESIGN.

Development of a nuclear fuel consisting of tiny spheres of uranium coated with pyrolytic graphite. The coating prevents fission products release and cuts down on the need for elaborate radiation shields. Nuclear cross sections and melting points are compared with those of other cladding materials such as Mg, Be, Zr and alumina.

Iron & Steel, v. 35, Apr. 1962, p. 139.
MACHINABLE STAINLESS STEEL CARBIDE.

Metal Industry, v. 99, Dec. 15, 1961, p. 473.
METALS IN SPACE.

Review of alloys used for space flight components including Al, Mg, Be and Th and their physical and mechanical properties. Structures include control surfaces, pressure vessels for liquid, heat sinks and honeycomb frame structures.

Metal Progress, v. 80, Dec. 1961, p. 9.
BERYLLIDES – NEW HIGH TEMPERATURE MATERIALS.

Beryllide intermetallic compounds promise to extend maximum service temperatures 40% beyond the range of Co and Ni-base superalloys. Made by combining Be and a refractory metal such as Ta, beryllides show an important advantage over the refractory metals in that they are resistant to oxidation up to 3000°. They also possess high specific heat and good thermal conductivity for heat sink applications.

Metal Treatment and Drop Forging, v. 28, Dec. 1961, p. 499-505.
MATERIALS FOR ATOMIC ENERGY.

Mining Journal, v. 257, Dec. 29, 1961, p. 681.
PROPERTIES AND USES OF BERYLLIUM.
Review of the melting point and neutron absorption cross section of Be and its use in aero and spacecraft components including fuselage, inlet ducts, disk brakes and rocket engine components. (P11, T24e; Be)

Power Reactor Technology, v. 5, Mar. 1962, p. 4, 6-8.
CROSS SECTIONS.
Reveiw of recent theoretical calculations and measurements of various neutron cross sections (scattering, radiative capture, thermal average, effective, fission) and their temperature and energy dependence for Be, Th^{232}, Np^{239}, -240 and -241. 11 ref.

Precision Metal Molding, v. 19, Oct. 1961, p. 60-67.
THE PHYSICAL AND MECHANICAL PROPERTIES OF METALS AND ALLOYS.
Properties of metals are tabulated for applications in plaster mold, die, permanent mold and investment castings and extrusions.

Precision Metal Molding, v. 20, Feb. 1962, p. 40-41.
ISOSTATIC PRESSING.

Reactor Core Materials, v. 3, Aug. 1960, p. 37-50.
CLADDING AND STRUCTURAL MATERIALS.
Corrosion resistance of Zr, Cb, Al stainless steel and Fe, Ni and Co alloys in nuclear applications. Mechanical properties of Zr, Cb stainless steel, W, Mg and Mg alloys. Effects of radiation on nonfuel materials. 82 ref.

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MODERATOR MATERIALS.

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"Review of recent work on graphite, Be metal..."

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Steel, v. 149, Oct. 16, 1961, p. 115-116.
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NEW MATERIALS, TECHNIQUES INCREASE VERSATILITY OF CERAMICS.

AD-241410
Lockheed Aircraft Corp., Sunnyvale, Calif.
GENERAL RESEARCH IN MATERIALS AND PROPULSION. VOLUME II. METALLURGY AND CHEMISTRY. Technical rept. Jan 59-Jan 60. lv. incl. illus. tables. (Rept. no. LMSD-288140, vol. 2)
CONTENTS: Electronic structure of beryllium, by G. C. Kuczynski (AD-266302)
Electrical resistivity of beryllium, by J. Ho and E. S. Wright
Plastic deformation in beryllium, by E. C. Burke

Beryllium analyzed for trace impurities by gamma-ray activation, by W. Bradshaw, R. Johnson, and D. Beard
High-temperature corrosion of beryllium in air, by W. Bradshaw and E. S. Wright
Stress corrosion cracking of beryllium, by C. M. Packer (LMSD-49735)
Grain refinement in beryllium by alloying, by D. Crooks and H. Sumsion
Specific heats of beryllium and an alloy at room and elevated temperatures, by E. Kanazawa and C. M. Packer (LMSD-2702)
Studies of the gas carburization of niobium, by A. Ottenberg
Study of halide-containing oxide films on columbium, by F. J. Clauss and S. Drake (See also AD-241409)

AD-254258
Ladish Co., Cudahy, Wis.
BERYLLIUM FORGING PROGRAM, PHASE III. INTERIM ENGINEERING REPORT NO. 4. MAR. 1, 1960 to DEC. 31, 1960. A. F. Hayes

AD-255963
Naval Ordinance Test Station, China Lake, Calif.
HIGH TEMPERATURE HEAT CAPACITY EQUATIONS AND THERMODYNAMIC PROPERTIES OF COMBUSTION GASES. Mary M. Williams.

Thermodynamic data are given for compounds of: H, O, N, C, Li, Na, K, Rb, Cs, Mg, Al, F, Cl, Br, Bc, B, Si and Ca. Standard state heat of formation, reference enthalpy and entropy and heat capacity equations are given for compounds shown to exist in high-temperature combustion processes.

AD-261792
Aerospace Technical Intelligence Center, Wright-Patterson Air Force Base, Ohio.
DETERMINING THE ENTHALPY AND SPECIFIC HEAT CAPACITY OF BERYLLIUM IN THE INTERVAL 600 – 2,200°K. P. B. Kantor, R. M. Krasovitskaya and A. N. Kisel'. June 27, 1961, 6 p. (Trans. no. MCL-950 of Fizika Metallov I Metallovedeniye 10:835-837, 1960).

Experimental determination of the enthalpy, melting point and heat of the transition phase of pure Be in the solid and liquid states from 600-2000°K.

AD-264825
Metals and Ceramics Lab., Wright Air Development Div., Wright-Patterson Air Force Base, Ohio.
ELEVATED TEMPERATURE SYNAMIC ELASTIC MODULI OF VARIOUS METALLIC MATERIALS. REPT. for Aug. 1959-July 1960, On Metallic Materials. W. H. Hill and K. D. Shimmin. Mar. 1961. 75 p. 32 refs (Proj. no. 7351) WADD TR 60-438.

Effects of room and elevated temperatures, speed of sound in materials, and elasticity on dynamic elastic moduli which are calculated from the geometry of 40 metals and alloy specimens. Electrostatic excitation of specimens to determine resonant frequency.

AD-269866
Coordinated Science Lab., U. of Illinois, Urbana. Progress Rept. for Sept-Nov. 1961. Nov. 1961, 27 p. (Contract DA 36-039-sc-85122).

AD-271508

Aeronutronic, Newport Beach, Calif.
THERMODYNAMIC PROPERTIES OF ROCKET COMBUSTION PRODUCTS. Quarterly technical progress rept. no. 2, D. L. Hildenbrand and L. P. Theard. February 1962, 24p. 9 ref. (Pub. no. U-1546) (Contract AF 04(611)7422).

AD-271582

Research Chemicals, Inc., Burbank, Calif.
PROPERTIES OF YTTRIUM AND THE RARE EARTH METALS OXYGEN AND ALLOY SYSTEMS. Rept. for Oct. 1959-Oct. 1960 on Metallic Materials, Bernard Love. August 1961. 179p. 49 ref. (WADD TR 61-123) (Contract AF 33(616)6829, Proj. 7351)

AEC-tr-4688

Akademiya Nauk S. S. S. R. Ordena Lenina Institut Atomnoi Energii
THE INFLUENCE OF TEMPERATURE ON THE SCATTERING OF THERMAL NEUTRONS ON BAKED BERYLLIUM OXIDE.
I. F. Zhezherun and A. A. Chernyshov. 1960. 18p.

AEC-tr-4689

Akademiya Nauk S. S. S. R. Ordena Lenina Institut Atomnoi Energii
MEASUREMENT OF THE SLOWING DOWN LENGTH OF FISSION NEUTRONS TO 0.3 eV IN BAKED BERYLLIUM OXIDE. 1960. 19p.
I. F. Zhezherun, I. P. Sadikov and A. A. Chernyshov.

AEC-tr-4691

Akademiya Nauk S. S. S. R. Ordena Lenina Institut Atomnoi Energii
MEASUREMENT OF THE SLOWING DOWN LENGTH OF FISSION NEUTRONS TO 1.44 eV (INDIUM RESONANCE) IN BAKED BERYLLIUM OXIDE. 1960. 21p. I. F. Zhezherun, I. P. Sadikov, V. A. Taraban'ko and A. A. Chernyshov.

Measurement of the slowing down density for a point source of fission neutrons in BeO at distances up to 90 cm from the source.

ASME Paper 62-AV-14

American Society of Mechanical Engineers
CRYOGENIC PROPELLANT-TANK STRUCTURES. Jack B. Esgar 1962. 13p.

ASTM Special Technical Publication 276

American Society for Testing Materials, Philadelphia, Pa.
REFRACTORY URANIUM COMPOUNDS – PREPARATION AND PROPERTIES. M. J. Snyder and A. B. Tripler, Jr. Paper from "Materials in Nuclear Application" 1960. p. 293-300.

BMI-1530

Battelle Memorial Inst., Columbus, Ohio
THE COMPATIBILITY OF GAS COOLANTS AND CERAMIC MATERIALS IN COATED-PARTICLE NUCLEAR FUELS. Arthur Levy and John F. Foster, July 1961. (Contract W-7405-eng-92) 31p.

CF-54-10-106

Oak Ridge National Lab., Tenn.
THERMAL STRESSES IN BERYLLIUM. TEST NO. 1. October 1954.
R. W. Bussard and R. E. MacPherson.

Simulation of the high power density volume heat source effect by electrical resistance heating of a Be block to observe removal of internally generated heat at 1100 to 1200°F.

CW-R&DL-14

Canadian Westinghouse Co., Ltd. Research and Development Labs., Hamilton, Ont.

ANNUAL REPORT ON BERYLLIUM RESEARCH, 1960. W. D. Bennett. February 1961.

Study of ductile brittle transition at high temperatures, corrosion resistance, ductility, stress rupture properties and the influence of heat treatments on the mechanical properties of Be. Pressure welding techniques. Bright field illumination and polarized light indicating structure changes due to heat treatments.

DC-60-4-80

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati

COMPILATION OF PROPERTIES OF BERYLLIUM INTERMETALLIC COMPOUNDS. G. C. Huth and J. P. Smith. April 1960. 15p. (Contract AT (11-1)-171)

DMIC Memo 105

Defense Metals Information Center, Battelle Memorial Institute

REVIEW OF RECENT DEVELOPMENTS IN THE METALLURGY OF BERYLLIUM. Webster Hodge. May 1961. 5p.

Summary of DMIC reports (February 1-April 30, 1961), covering purification by zone refining and distillation and metallographic examination and measurement of mechanical and physical properties as a function of composition, heat treatment and fabrication and working processes.

DMIC Memo 148

Defense Metals Information Center, Battelle Memorial Institute

EMITTANCE OF CERAMICS GRAPHITE. W. D. Wood, H. W. Deem, and C. F. Lucks. March 1962. 106p.

Normal spectral and total emittance, spectral reflectance and hemispherical total emittance data are given for various carbides, graphites, Ni-Ti carbide hard metals, oxides, nitrides, pyrocerms and silicides.

DMIC Report 142

Battelle Memorial Institute

ENVIRONMENTAL FACTORS INFLUENCING METALS APPLICATIONS IN SPACE VEHICLES. December 1960. 46p.

Study of the influence of solar, planetary and low-density atmospheres, meteoritic dust, high energy particles, electromagnetic radiation and gravity on metals. Investigation of metals under atmospheric entry conditions and of metals for energy-conversion and utilization systems.

DMIC Report 160

Battelle Memorial Institute

INTRODUCTION TO METALS FOR ELEVATED-TEMPERATURE USE. J. E. Campbell, H. B. Goodwin, H. J. Wagner, R. W. Douglas and B. C. Allen. Defense Metals Information Center. October 1961. 70p.

GA-848

General Atomic Div., General Dynamics Corp., San Diego, Calif. THE CONTINUOUS OPACITY AND EQUATIONS OF STATE OF LIGHT ELEMENTS AT LOW DENSITIES. Jeremy Bernstein and Freeman J. Dyson. July 13, 1959. 35 p. Project No. 52. Contract AF19(600)-1812.

An approximate method for computing the opacity of light elements at low densities ($\sim 10^{-3}$ g/cm^3) in the Rydberg temperature range is described. Based on this method, a code was developed for which results for H, He, Li, Be, B, C, N, O, and F at various temperatures and densities are reported.

GA-2065

General Atomic Div., General Dynamics Corp., San Diego, Calif. STABILITY OF BE-O-UO_2 REACTOR FUEL MATERIAL DURING IRRADIATION. MARITIME GAS-COOLED REACTOR PROGRAM. Mar. 31, 1961. Dale E. Johnson.

The effect of irradiation on grain size matrix lattice parameter, crushing strength and abrasion resistance for BeO matrix fuel pellets dispersed in UO_2 at very high temperature.

LMSC-6-90-61-75

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif. THE ELECTROLYTIC POLARIZATION OF BERYLLIUM. TECHNICAL REPORT. D. J. Levy Nov. 1961. 14 p.

LMSD-48472

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif. BERYLLIUM DESIGN DATA. Apr. 29, 1959.

LMSD-288003

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif. ELECTRONIC STRUCTURE OF BERYLLIUM. Aug. 1959. 29 p.

An attempt is made to correlate the structural insensitive physical properties of beryllium based on the theory of solids. An explanation of the decrease of lattice parameters ratio with temperature is offered, based on the Herring-Hill calculations of the wave functions for beryllium. The only real anomaly not properly explainable by the Herring-Hill model was found to be a very low value of Poisson's ratio.

LMSD-288139 (Vol. II)(Paper 6)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif. ON DETERMINING BIAXIAL-STRESS YIELD AND FRACTURE CRITERIA FOR HOT PRESSED BERYLLIUM AT ROOM AND ELEVATED TEMPERATURE. R. F. Crawford. Paper 6 of GENERAL RESEARCH IN FLIGHT SCIENCES, January 1959-January 1960. Volume II. MECHANICS OF DEFORMABLE BODIES. 37 p.

The classical criteria for yield and fracture strengths of materials in biaxial states of stress must be applied selectively. The proper selection depends upon the particular metallurgical mode of failure involved, which, even for a given material, depends upon the particular biaxial state of stress as well as other factors. In the case of beryllium, added complications can arise from directionalities that are the result of preferred orientation of the grain lattice structure.

The above considerations are discussed and modified criteria for yield and fracture are introduced to account for preferred orientations. Recommended testing procedures are presented along with a brief bibliography.

LMSD-288140

Lockheed Aircraft Corp., Sunnyvale, Calif.
GENERAL RESEARCH IN MATERIALS AND PROPULSION METALLURGY AND CHEMISTRY. v. 2. Jan. 1959-Jan. 1960, 244 p.

Articles dealing with the electronic structure, electrical resistivity, plastic deformation, high temperature corrosion, stress corrosion, cracking, effects of temperature on specific heat and analysis of trace impurities by gamma-ray activation of Be. Studies are included on the gas carburization of Cb and the effect of halide-containing oxide films on Cb. 119 ref.

LMSD-288140 (Vol. II)

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
ELECTRONIC STRUCTURE OF BERYLLIUM. G. C. Kuezynski. Paper 1 of General Research in Materials and Propulsion, January 1959 to January 1960. Volume II. 26 p. This paper is a reprint from LMSD-288003, dated Aug. 1959.

An attempt is made to correlate the structure insensitive physical properties of beryllium on the basis of the theory of solids. Special attention is paid to the thermal, elastic and electrical properties. An explanation of the decrease of lattice parameters ratio with temperature is proposed based on the Herring-Hill calculations of the wave functions for beryllium. Recommendations are made for experimental work toward the increase and completion of the information concerning the physical properties of beryllium.

LMSD-288218

Lockheed Aircraft Corp. Missile and Space Div., Sunnyvale, Calif.
ELECTRICAL RESISTIVITY OF BERYLLIUM. Technical Memorandum. J. Ho and E. S. Wright, Jan. 1960, 24 p. Contract NOrd 17017. This paper was originally printed under the same title in Vol. II "Metallurgy and Chemistry," of General Research in Materials and Propulsion, January 1959-January 1960, LMSD-288140.

Research concerning the effects of impurities on the electrical resistivity of beryllium is described. Investigation of the electronic structure of this metal is also discussed along with a study of the relationship of its electrical and themal conducivities.

MR-120

General Motors Corp., Detroit, Mich.
AN INVESTIGATION OF THE PRECISION MECHANICAL PROPERTIES OF SEVERAL TYPES OF BERYLLIUM. Thomas J. Hughel. April 4, 1960, 26p., incl. illus. tables.

NAA-SR-5363

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
CORROSION AND ACTIVITY TRANSFER IN THE SRE PRIMARY SODIUM SYSTEM. H. E. Johnson. Oct. 30, 1961. Contract AT-11-1-GEN-8. 42 p.

NAA-SR-Memo-4579

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
COMPARATIVE PROPERTIES OF DISPERSION-ELEMENT COMPONENTS.
J. Kroehler, Jr. September 1959. 11p.

Patented fissile materials and matrices available for use in OMR were compared. Thermal conductivities, coefficients of thermal expansion, cross sections, and relative amounts of wt. % contributed to the fuel element were compared for ten matrix materials. The most promising of these appeared to be Al, Be, Mg, and Zr. Uranium contents, absorption cross sections, and relative stabilities were compared for fifteen fissile materials. The most promising of these dispersants appeared to be UC, UO_2, UC_2, UN, and U_2Si_2.

NBS-6645

National Bureau of Standards, Washington, D. C.
PRELIMINARY REPORT ON THE THERMODYNAMIC PROPERTIES OF SELECTED LIGHT-ELEMENT COMPOUNDS (SUPPLEMENT TO NBS REPORTS 6297 and 6484). Third Technical Summary Report to the Advanced Research Projects Agency on the Thermodynamic Properties of Light-Element Compounds. January 1960. Amended April 1, 1960. 95p.

Previously published data on the thermodynamic properties of nitrides and carbides of Li, Be, Mg, Al, and Ti are reviewed. Entropies and high-temperature heat capacities were estimated. Data on the thermodynamic properties of graphite, solid and liquid Ti, and N gas are reviewed. Heats of formation are reported for the perchlorates of NH_4, Li, and K. Data on the vapor pressure and degree of dissociation of $AlH_3 \cdot 2N(CH_3)_2$ are given. Studies on the reactions of NH_3 with the hydrides of Al and Be are reviewed.

NBS Monograph 21

SPECIFIC HEATS AND ENTHALPIES OF TECHNICAL SOLIDS AT LOW TEMPERATURES. Robert J. Corruccini and John J. Gniewek. October 1960. 20p.

Data for specific heats and enthalpies from 1-300°K of several metals, graphite natural rubber, plastics and other material.

NEPA-1100

Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.
COMPARATIVE CRITICAL CONDITIONS IN SIMPLE NUCLEAR REACTORS. A. O. Mooneyham. August 1949. Decl. July 18, 1961. 48p. (Contract W-33-08-ac-14801(16250))

Comparison of physical and nuclear properties and critical size in homogeneous, gas-cooled, enriched, cylindrical and room temperature reactors, containing H, BeO, BeC, U-235, Fe and graphite.

NEPA-1590

Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.
STUDY OF GENERALIZED DILUENTS IN REACTORS OF FIXED GEOMETRY. W. H. Long. October 1950. 64p. (Contract W-33-08-ac-14801(16250))

Effect of diluent cross sections of Be metal, BeO and Be_2C with added graphite on the calculated critical mass.

NMI-1238
Nuclear Metals, Inc.
IMPURITY EFFECTS IN COMMERCIALLY PURE BERYLLIUM.
S. H. Gelles and A. K. Wolff. February 1961. 74p.

NP-9639 (Vols. 1 and 2)
Dow Chemical Co. Thermal Lab., Midland, Mich.
JANAF INTERIM THERMOCHEMICAL TABLES. VOLUMES 1 AND 2.
T. E. Dergazarian, N. J. Dumont, L. A. du Plessis, W. E. Hatton, S. Levine, et al. December 1960. (Contract AF 33(616)-6149)

"... set of thermochemical tables is presented for rocket performance calculations. The tables include data on compounds of Al, B, Be ..."

ORNL-3017 (p. 116-24)
Oak Ridge National Lab., Tenn.
RADIATION METALLURGY. O. Sisman, R. G. Berggren, et al.

The brittle fracture program for pressure-vessel steels was extended to include isothermal annealing studies. The results of impact tests showed some recovery at 400°F and 90% recovery at 850°F. In the tensile tests, slight recovery was observed between 250 and 400°F, and a very complicated behavior between 400 and 600°F was observed. A final stage of recovery was observed above 600°F. Stress-rupture studies were continued on Inconel and type 304 stainless steel by in-pile tube burst tests. Studies have also been initiated for beryllium, niobium, and Zircaloy-2. Tube burst tests are presently being assembled for all three new materials. Several experiments were run to determine the effect of internal helium generation on the physical and mechanical properties of beryllium. First tests on a high-temperature irradiation indicated that the swelling was much greater than observed from low-temperature irradiation followed by postirradiation annealing.

ORNL-3127
Oak Ridge National Lab., Tenn.
REACTOR CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1961. May 1961.

PB-161093
National Bureau of Standards. Cryogenic Engineering Lab., Boulder, Colo.
CRYOGENIC MATERIALS DATA HANDBOOK. 195?. 22p. (Contract AF 04(647)-59-3)

Data on the physical properties of Al, Co, Cu, Fe, Ni, Ti, carbides, non-metals, Be, and Mo over the temperature range -423 to +500°F are included.

PB-171809
Cryogenic Engineering Laboratory, National Bureau of Standards. (Ballistic Missile Div.)
CRYOGENIC MATERIALS DATA HANDBOOK. T. F. Durham. September 1961. 555p.

PG-Report-171 (p. 55-72)

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England
THE DETERMINATION OF BERYLLIUM BY THE PHOTONEUTRON METHOD. G. W. C. Milner and J. W. Edwards.

Investigation of interferences in the analysis of B, Cd, Sm, Gd and Sb caused by high thermal-neutron cross sections and large concentrations of deuterium.

UK-10

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England
EUROPEAN ATOMIC ENERGY SOCIETY – STOCKHOLM 1959 – THE EFFECT OF IRRADIATION UPON BERYLLIUM. Robert S. Barnes. 3p.

Beryllium undergoes two nuclear reactions with fast neutrons. The effects on the material become more important at high doses and operating temperatures. A discussion of these effects is presented with brief reference to those of the normal atomic displacements.

WADC-TR-58-476 (Vol. II) (Rev.)

Illinois Inst. of Tech., Chicago. Armour Research Foundation.
THERMOPHYSICAL PROPERTIES OF SOLID MATERIALS. VOLUME II: ALLOYS (MELTING TEMPERATURE ABOVE 1000°F). Revised Edition. Alexander Goldsmith, Harry J. Hirschhorn, and Thomas E. Waterman. June 1960. 608p. (Contract AF 33(616)-5212)

Thermophysical property data, and their variation with temperature are presented for alloys melting above 1000°F, based on literature published during the period 1940 through 1957. Properties covered include melting point, density, latent heats, specific heat, thermal conductivity, thermal diffusivity, emissivity, reflectivity, thermal expansion, vapor pressure, and electric resistivity. Fe, Cu, Ni, Co, Al, Mg, Ti, Be, Au, Ag, Pt, Pd, Mn, V, Si, and refractory metal alloys were investigated.

WADC-TR-58-478 (Pt. II)

Brush Beryllium Co., Cleveland
DEVELOPMENT OF WROUGHT BERYLLIUM ALLOYS OF IMPROVED PROPERTIES. PERIOD COVERED: JULY 1, 1958 TO JUNE 30, 1959. John G. Klein, Leslie M. Perelman, and Wallace W. Beaver. September 1959. 128p. (Project 7351) (USAF Delivery Order 33(616) -57-19)

SECTION V. BERYLLIUM METALLURGY

PART N. MECHANICAL PROPERTIES AND TESTS

Aldred, F. H., and N. W. Hinchliffe
GENERAL DEVELOPMENT IN CERAMICS FOR MARINE ENGINEERING. American Society of Naval Engineers, Inc., Journal, v. 73: 453-462 (August 1961)

Amoenko, Tukhunskii, Finkel, Azhazha and Shpazin
PLASTIC DEFORMATION OF TEXTURED BERYLLIUM. Soviet Physics — Solid State, v. 3: 580-584 (Translation of Fizika Tverdogo Tela, v. 3: March 1961)
Be foil of 99.987% purity is obtained by condensation of Be vapor in vacuum (10^{-6} mm. Hg) on a Mo substrate. The texture of the foil is observed as a function of the condition of the substrate, the foil having its basal (001) plane coincident with the condensate for a neutral substrate and a 45° inclination for a rolled, degassed Mo substrate. Temperature variation of plasticity and elongation is determined for three foil textures at 20-800° C.

Asundi, M. K.
THE ROLE OF LIGHT METALS IN NUCLEAR ENGINEERING. Paper from SYMPOSIUM ON LIGHT METAL INDUSTRY IN INDIA. National Metallurgical Laboratory, Jamshedpur, India, 1961, p.171-179.

Ball, J. G.
MATERIALS IN ATOMIC ENERGY. Nuclear Power, v. 5: 79-90 (December 1960)

Barchiesi, G.
BERYLLIUM BRONZES. Fonderia, v. 10: 548-551 (December 1961) (Italian)

Barnby, J. T.
MICROCRACKS IN BERYLLIUM. Institute of Metals, Journal, v. 90: 271-272 (March 1962)
Round tensile specimen of Be are tested to fracture at 100-150° C. Slip lines are attributed to basal slip with cracking determined by the microstructure analysis. Microscopic examination to determine cracking mechanisms.

Barnes, R. S. (Atomic Energy Research Establishment, Harwell, Berks, Eng.)
RADIATION EFFECTS IN CLADDING MATERIALS. From FUEL ELEMENT FABRICATION WITH SPECIAL EMPHASIS ON CLADDING MATERIALS. vol. 2. London and New York, Academic Press, 1961, p. 93-104.

Barnett, R. L. and A. Humphreys
DESIGN FOR MINIMUM WEIGHT. Materials in Design Engineering, v. 55: 83-85 (January 1962)
Data are given for specific stiffness, tenacity and compressive strength and weight/strength ratio for aircraft, missile and engineering materials including Al, steel, Mg, Ti, boron carbide, Be and B and their alloys.

Bastien, P. and P. Pointu
DETERMINATION OF GLIDE ELEMENTS IN HEXAGONAL METALS BY ASTERISMS IN LAUE PHOTOGRAPHS AND APPLICATION TO THE STUDY OF DEFORMATION OF BERYLLIUM AT HIGH TEMPERATURES. Journal of Nuclear Materials, v. 5: 101-108 (January 1962) (French)

New modes of deformation active at high temperatures, with glide components along the hexagonal axis, are determined for single crystals of Be cleaved at 1000° C by analysis of asterisms occurring in Laue back reflection X-ray patterns.

Bastien, P. and P. Pointu
MODES OF DEFORMATION OF BERYLLIUM AT HIGH TEMPERATURE AND RECRYSTALLIZATION AFTER TWINNING. Journal of Nuclear Materials, v. 5: 153-155 (January 1962) (French)

Metallographic and X-ray examination of orientation of active deformation modes, relations and recrystallization and grain growth phenomena in twinned single crystals of Be cleaved at 800-1000° C with subsequent heat treatment at 750° C.

Beckett, F. J. and P. Burtenshaw
VACUUM HEAT TREATMENT. Metallurgia, v. 65: 107-111 (March 1962)

Bennett, W. D.
RESEARCH IN BERYLLIUM. Canadian Metalworking, v. 24: 29-31 (July 1961)

Bernstein, B. T.
A CALCULATION OF THE ELASTIC SHEAR CONSTANTS OF BERYLLIUM. Journal of Applied Physics, v. 33: 142-144 (January 1962)

Calculation of the Fermi, electrostatic and ion core contributions to the elastic shear constants of Be using an energy band model.

Biefer, G. J. and F. H. Krenz
CORROSION OF ALUMINUM-NICKEL-IRON ALLOYS IN HIGH TEMPERATURE WATER. Paper from HIGH PURITY WATER CORROSION OF METALS. National Assoc. of Corrosion Engineers, Houston, Tex. p. 1-16.

Effect of minor additions of Zr, Be and Ti on corrosion resistance. Maximum benefit is obtained by the addition of Be and Ti together with or without Zr. The best alloy has the composition 2% Ni, 0.5% Fe, 0.2% Si, 0.2% Ti, 0.05% Be and 0.05% Zr, balance Al.

Blair, R. W., D. L. Johnson and J. P. Morley
METAL BELLOWS SEALS. Lubrication Engineering, v. 17: 470-475 (October 1961)

Flexure fatigue and tensile testing of seals indicating spring rate variation in terms of temperature, mean diameter and thickness; modulus of elasticity; pressure limits; and amount of cracking. Hydraulic forming and welding of 316, 321, 347, 17-7PH and AM-350 stainless steels, phosphor bronze, beryllium copper, 6061 T-6 Al, Ti and Ni alloys to produce a corrosion resistant seal for use at high and low temperatures.

Bohm, Horst
PRECIPITATION CHARACTERISTICS OF BINARY COPPER ALLOYS AS INFLUENCED BY ADDITIONS OF A THIRD ELEMENT. Zeitschrift fur Metallkunde, v. 52: 564-571 (September 1961) (German)

Brown, A. B., A. J. Martin and J. Morrow
THE EFFECT OF STRAIN RATE AND HEAT TREATMENT ON THE TENSILE PROPERTIES OF EXTRUDED BERYLLIUM RODS BETWEEN 25° AND 600° C. Less-Common Metals, Journal, v. 3: 62-88 (February 1961)

Buckle, H.
NEW AERONAUTIC MATERIALS. Technique Moderne, v. 53: 53-64 (July 1961) (French)

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STRUCTURAL WEIGHT ESTIMATES FOR NOVEL CONFIGURATIONS. Royal Aeronautical Society, Journal, v. 66: 15-30 (January 1962)

Butcher, J. and A. J. Martin
A ROOM-TEMPERATURE AGEING EFFECT OBSERVED IN COMMERCIALLY PURE BERYLLIUM. Institute of Metal, Journal, v. 90: 191-192 (January 1962)

Effects of aging on ductility, yield strength and elongation of tensile specimens prepared from powder hot pressed at 1100° C, quenched at 600-900° C and tested at 50° intervals between 25 and 600° C. Ductility after 20-30 days aging is affected by quenched-in-impurities which diffuse in the metal at room temperature.

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EVALUATION OF SPECIAL METAL PROPERTIES. Defense Metals Information Center, Review of Recent Developments, 4 p. (January 1962)

Tensile properties of Ti-5Al-2.5 Sn, 2014-T6, 2014-T62, 2219-T81, 2219-T62, 2219-T31, 2618-T6 and 2618-T62 sheet Al alloys at -423° F. Fracture toughness of high strength sheet alloys — 6434 steel, Ti-6Al-4V and Ti-13V-11Cr-3Al alloys.

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FORGINGS IN MISSILES AND SPACE VEHICLES. Aircraft Production, v. 23: 188-193 (May 1961)

Carlson, Harold C. R.
SPRING DESIGN DATA. Wire and Wire Products, v. 36: 76 (January 1961)

". . . comparative costs are given for wire composed of phosphor bronze, brass, Be-Cu. . ."

Carson, Robert W.
FLAT SPRING MATERIALS. Product Engineering, v. 33: 68-81 (June 1962)

Consideration of the mechanical properties and temperature limits of pre-tempered, annealed and hardened carbon and stainless steels, Cu alloys, corrosion and heat resistant alloys and constant modulus alloys used for the production of flat springs. Effect of fine grain structure on deformation, formability and endurance.

Chironis, Nicholas P.
55% THREAD DEPTH WILL MAKE BERYLLIUM BOLTS PRACTICAL. Product Engineering, v. 31: 75-77 (November 1960)
Use of a new thread form, with a large root radius and a thread depth only 55% of the theoretical, to increase fatigue strength of Be bolts. Tensile, shear and fatigue strength of Be, Ti, and steel bolts.

Churchman, A. T.
PHYSICAL METALLURGY AND SOLID STATE PHYSICS IRRADIATION EFFECTS. Pt. 12. IRRADIATION EFFECTS IN NON-FISSILE MATERIALS. Chapter 2 from PROGRESS IN NUCLEAR ENERGY. Series 5. METALLURGY AND FUELS. v. 3. Pergamon Press, Inc., New York 22, 1961, p. 347-370.
Summary of reactor material studies including irradiation hardening of Cu, Zr, Mo, Ti, mild steel, stainless steel, LiF, Cb; formation of thermal spikes in U-Mo alloys, Ga, Bi, GaSb and InSb; annealing radiation damage in Cu, Fe, Ni and Al; embrittlement in b-c-c. structures, such as Armco iron and low-alloy steel; atom redistribution, affecting creep and precipitation, in Cu, Ni, Be and Al alloys; isotopic transmutation of Mn and B; and thermal cycling and corrosion as caused by irradiation.

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BRAZING BERYLLIUM FOR AEROSPACE APPLICATIONS. American Welding Society, 43rd Annual Meeting, April 1962. Technical Abstract.

Cooke, V. W. and R. C. Powell
PRESSURE VESSELS FOR SPACE, AEROSPACE AND HYDROSPACE-A SYMPOSIUM. PT. 2. MATERIALS FOR SPACE PRESSURE VESSELS. Journal of Metals, v. 13: 198-201 (March 1961)
Comparison of steels, Al alloys and Ti alloys as to strength-weight ratio, ductility, fracture toughness, fabricability, corrosion resistance and stability in pressure vessel applications.

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MECHANICAL AND AEROTHERMODYNAMIC DESIGN OF TORY IIA. Aerospace Engineering, v. 21: 8-20 (June 1962)

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PROGRESS IN BERYLLIUM METALLURGY. Nuclear Power, v. 6: 75-76 (December 1961)
Review of the mechanical and physical properties of Be including tensile strength, elongation, ductility and age hardening for use in reactors, missiles, space vehicles and aircraft.

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MECHANICAL METALLURGY. McGraw-Hill Book Co., New York 36, 1961, 615p.

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A RAPID ELECTROLYTIC METHOD FOR THE PREPARATION OF METALLOGRAPHIC SURFACES ON FABRICATED BERYLLIUM. Institute of Metals, Journal, v. 90: 270-71 (March 1962)

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BONDING BERYLLIUM. Adhesives Age, v. 5: 22-24 (January 1962)

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EARLY AGING EFFECTS IN COPPER 1.76% BERYLLIUM SINGLE CRYSTALS. Paper from ADVANCES IN X-RAY ANALYSIS, v. 1. Plenum Press, Inc., New York, 1960, p. 143-162.

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MATERIALS PROPERTIES IN BENDING. Machine Design, v. 34: 181-186 (May 1962)
Comparison of spring materials yield strength in bending and tension and elastic modulus in bending. Determination of stress-deflection relationships, effects of decarburization and Cu plating on spring steel, Be-Cu Alloy 25, phosphor bronze and Cu-double-clad on carbon spring steel.

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ULTRASONIC WELDING MACHINES. Mecanique et Electricite, v. 46: 29-38 (January 1962) (French)

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MATERIALS FOR NUCLEAR POWERPLANTS. Space/Aeronautics, v. 37: 75-79 (April 1962)

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ADVANTAGES OBTAINED FROM THE USE OF CAST TOOLS. Machinery, v. 101: No. 2597, 430-434 (August 1962)

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SHOT-PEENING OFFERS NEW LIFE TO CRITICAL METAL PARTS. Iron Age, v. 188: 67-70 (August 1961)
Fatigue strength of steel shaft, springs and gears, Be-Cu springs...

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WHISKER-THIN BERYLLIUM WIRE. Materials in Design Engineering, v. 55: 10 (March 1962)
Ultra fine Be wire 0.005-in. in diameter shows increased tensile and yield strength and an improved strength-weight ratio compared to conventional Be wire. Nuclear, aerospace and electronic applications.

Gage, Paul E.
WHAT BERYLLIUM CAN DO FOR YOU. Product Engineering, v. 32: 82-85 (February 1961)

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ORIENTATION DEPENDENCE OF THE SLIP AND FAILURE OF BERYLLIUM SINGLE CRYSTALS IN TENSION. Soviet Physics — Solid State, v. 3: 832-837 (October 1961)
Study of mechanical properties and crystallographic elements of plasticity and failure at 20° C with determination of critical shear, fracture stresses and relative elongation. Resultant data agree with rule of constancy of normal and shear stresses in brittle fractures.

Garber, R. I. and I. A. Gindin
THE PHYSICAL PROPERTIES OF METALS OF HIGH PURITY. Soviet Physics – Uspekhi, v. 4: 405-424 (December 1961) (Translation - AIP)

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PHYSICS OF THE STRENGTH OF CRYSTALLINE MATERIALS. Soviet Physics – Uspekhi: 41-77 (July-August 1960) (Translation - AIP)
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Effect of surface reactions caused by the presence of an organic liquid, particularly dodecyl alcohol, on the rate of fatigue crack propagation in 4340 steel, 17-7PH stainless steel, 6061 Al alloy and a Cu-Be (1.75%) alloy is investigated by rotating-beam fatigue testing. Fatigue life is determined for both smooth and notched specimens in the cleaned and coated conditions.

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Effects of forging, machining, extruding and rolling on the tensile strength, elasticity, ductility and strength-to-weight ratio. Influence of metal purity and heat treatment on ductility. Brazing of Be to itself or other metals using Ag, AgLi and Be-20% Ag alloys.

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METALLURGISTS REPORT PROGRESS IN FORMING BERYLLIUM.

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MACHINABLE STAINLESS STEEL CARBIDE.

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Machinery, v. 68: March 1962, p. 147-148
SPRING DESIGN DATA-15 — MODULUS OF MATERIALS (DATA SHEET).
Modulus of elasticity in tension and in torsion is given for music wire, spring steel, stainless steel, O. T. chrome vanadium, beryllium copper, phosphor bronze and brass.

Metal Industry, v. 99: November 1961, p. 378-379
PROTECTION AGAINST METAL FATIGUE.
Fatigue tests are conducted on sharply notched cylindrical specimens of 4340 steel, 17-7 PH stainless steel, 6061-T6 Al alloy and Cu-1.75% Be alloy using a rotating-beam machine at 3000 rpm. The effect of dodecyl alcohol on fatigue crack propagation of cleaned and uncleaned metal specimens is determined by cycling at nominal stress amplitudes of 11.5-1000 psi.

Metal Industry, v. 99: December 1961, p. 473
METALS IN SPACE.

Metal Treatment and Drop Forging, v. 28: December 1961, p. 499-505
MATERIALS FOR ATOMIC ENERGY.
Summary of paper presented at the Engineering Materials and Design Exhibition and Conference reviewing the mechanical and physical properties of various materials including mild and stainless steel, Mg, U, Zr, Hf, Be, Cb and ceramics in relation to their use in nuclear reactors.

Metal Treatment and Drop Forging, v. 28: December 1961, p. 507-508
FATIGUE CRACK PROPAGATION IN METALS.
Notched fatigue testing of 4340 steel, 17-7 PH stainless steel, Cu-Be and 6061-T6 Al to determine the effect of the presence of an organic liquid, such as dodecyl alcohol, on fatigue strength.

Missiles and Rockets, v. 8: April 1961, p. 15
BREAKTHROUGH: BERYLLIUM PROVED INHERENTLY DUCTILE.
Single crystals of pure Be are prepared by repeated zone refining. Room temperature, tensile and bend test data are given for the basal plane angle, slip system, reduction in area, elongation, glide strain and basal shear stress.

Missiles and Rockets, v. 10: January 1962, p. 24
PROCESS EXTRUDES SMOOTH BERYLLIUM.
Use of a copper and steel composite lubricant to produce beryllium extrusions with smooth, crack-free surfaces. Effects of annealing on UTS, elongation and yield strength.

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THE PHYSICAL AND MECHANICAL PROPERTIES OF METALS AND ALLOYS.

Products Finishing, v. 25: July 1961, p. 78, 82-83
EFFECT OF ORGANIC COMPOUNDS ON METAL FATIGUE.
Increase in fatigue life of steel, Mg and Cu-Be alloys by coating with organic compounds. Compounds having a carbon chain of at least 12 with a polar group at one end are found to be most beneficial.

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"Effect of radiation on Be . . /"

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MODERATOR MATERIALS.
Effect of refining, melting, casting, electron-beam welding, and fabrication on physical and mechanical properties of Be and Be alloys . .

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" . . . metallurgical aspects of Al and Ag alloys, ... Be . . ."

Reactor Core Materials, v. 4: May 1961, p. 17-27
MODERATOR MATERIALS.
Review of recent work on graphite, Be metal, alloys and compounds, Zr hydride, Li hydride and Cb hydride. Casting, fabricating, rolling and joining techniques. Properties, including strength, elastic moduli, electrical resistivity, thermal expansion, structure, ductility, corrosion and irradiation effects.

Reactor Core Materials, v. 4: August 1961, p. 19-25
MODERATOR MATERIALS.

Space Aeronautics, v. 35: January 1961, p. 72-73
CRYOGENIC MATERIALS.
Tensile strength, elongation, area reduction, impact energy and elasticity modulus of 347 and 301 stainless, 17-4 PH stainless, 6061 Al and Berylco 25 as a function of temperature after annealing, quenching, cold rolling and precipitation hardening.

Steel, v. 149: October 1961, p. 115-116
1961 METAL SELECTOR.

Steel, v. 149: November 1961, p. 90
BERYLLIDE FAMILY HEADED FOR PLEIADES.

Steel, v. 149: December 1961, p. 50-54
NEW MATERIALS, TECHNIQUES INCREASE VERSATILITY OF CERAMICS.

Welding and Metal Fabrication, v. 29: March 1961, p. 101
METAL FATIGUE AND COLD EXTRUSION.

Review of research on fatigue of mild steel, Cu, Al, 4 1/2% Cu-Al alloy and Zn as affected by static ductility, fretting and abrasive wear and on cold extrusion of metals to improve surface finish and eliminate machining.

Western Machinery and Steel World, v. 53: January 1962, p. 40-42
NEW DEVELOPMENTS IN EXTRUDING BERYLLIUM TO AID SPACE AGE STRUCTURES.

AD-238485

Lockheed Aircraft Corp., Sunnyvale, Calif.
GENERAL RESEARCH IN FLIGHT SCIENCES. VOLUME II. MECHANICS OF DEFORMABLE BODIES. Technical Rept. January 1959-January 1960, 1 v. incl. illus. tables. (Rept. No. LMSD-288139, vol. 2)

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Approximate analysis of damped, linear vibrations.

Large deflection and buckling analysis of circular cylindrical shells.

Approximate buckling loads by energy methods.

On determining biaxial stress yield and fracture criteria for hot pressed beryllium at room and elevated temperature.

Stresses in spherical pressure vessels.

A statistical analysis of axially loaded cylinder buckling data.

Shock response of a nonlinear missile suspension system.

Elasto-plastic analysis of shells of revolution subjected to heating and external loads.

Spring characteristics of long tubular air cushions.

The initial response of an elastic spherical shell to a step pressure wave.

The effect of residual stresses on the critical crack length predicted by the Griffith theory.

Stresses generated by suddenly introducing a moving crack into a stretched elastic sheet.

AD-245339

Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT IN THE AREA OF COMPOSITE MATERIALS. Greenspan, Jacob, Henrikson, Gerald A., and Albert R. Kaufmann. Rept. for June 15, 1958 - June 14, 1959 on Metallic Materials. July 1960, 108 p. incl. illus. tables. (Contract AF 33(616)5912, Proj. 7351)

The general objective of the program was to investigate the

ductility properties of some beryllium composity materials in relation to the ductility of beryllium itself. An investigation of bend ductility in beryllium sheet as a function of sample width and sample thickness revealed that the magnitude of ductility was sensitive to grain orientation (i.e., fabrication history) as well as sample dimensions. For narrow samples (small width/thickness ratio), bend ductility was highest with a highly preferred basal plane texture. For wide samples (large width/thickness ratio), bend ductility was highest with a semi-random basal plane texture. In strip composites consisting of alternate strips of beryllium and aluminum or silver filler metal, the magnitude of bend ductility of the composite was generally intermediate between that of an individual beryllium strip and that of continuous beryllium as wide as the composite. Transverse strength of strip composites was found to be of the order of 1/8 - 1/4 that of beryllium. In clad composites the presence of a cladding did not institute unusual changes in the ductility of the composite. However, the presence of a cladding appeared to be significant as a "fall-safe" and surface-protection medium, and is suspected to be significant for any surface-sensitive property. Beryllium was amenable to cladding either rolling or extrusion if a thin silver interlayer was present between core and cladding. The presence of an aluminum or silver coating did not institute unusual changes in the ductility or tensile strength of the beryllium composite. Polishing methods for beryllium surfaces are described.

AD-249393

Metals and Ceramic Lab., Wright Air Development Div., Wright-Patterson Air Force Base, Ohio.
MECHANICAL PROPERTIES OF BERYLLIUM. A. E. Riesen, and R. T. Ault. Rept. March 1958-March 1960. September 1960, 29p. incl. illus. tables. (Project No. 7351) (WADD-TR-60-425)

The test procedures and results of a mechanical properties' determination program which included tensile, torsion, pin shear, creep rupture, and fatigue data on two lots of beryllium are presented. One lot of material was hot pressed with a BeO content of 1.45%; the other lot was hot pressed and hot extruded and contained 1.55% BeO. Emphasis was placed on the fatigue and creep rupture data. Fatigue tests were conducted at room and elevated temperatures with stress ratios of A equals infinity and 0.67. Both lots of material showed surprising strength under fatigue loading conditions whereas beryllium's inherent brittleness manifested itself under static loading conditions by the brittle fractures. The hot pressed-hot extruded material was uniformly stronger and therefore more desirable for design purposes than the material that was only hot pressed.

AD-258241

Nuclear Metals, Inc., Cambridge, Mass.
DEVELOPMENT OR RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F. M. Yans, A. K. Wolff, and A. R. Kaufmann. Rept. for May 1, 1959-April 30, 1960 on Metallic Materials. December 1960, 93p. incl. illus. tables. (Contract AF 33(616) 6616) (WADD-TR-60-403)

The effects of heat treatment, bidirectional rolling, annealing and compression rolling on texture, intensity profile, ductility and basal plane population.

AD-259441
Rolla Metallurgy Research Center, Bureau of Mines, Mo.
VAPOR DEPOSITION OF TUNGSTEN ON ROCKET NOZZLE INSERTS.
F. W. Hoertel.

AD-260313
Armour Research Foundation, Chicago, Ill.
DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES.

AD-265840
Brush Beryllium Co., Cleveland, Ohio.
ROLLING IMPROVED BERYLLIUM SHEET. Quarterly Rept. No. 1, July 4-October 4, 1961. E. M. Grala, R. G. O'Rourke, et al. October 1961. 24p. (Technical Rept. No. 231-234) (Contract AF 33 (600) 430-37)

AD-266343
Battelle Memorial Inst., Columbus, Ohio.
INVESTIGATION OF FATIGUE BEHAVIOR OF CERTAIN ALLOYS IN THE TEMPERATURE RANGE ROOM TEMPERATURE TO 423° F. Rept. for February 1, 1960-March 15, 1961, on Metallic Materials. Ronald J. Favor, Donald N. Gideon and others. June 1961, 116p. (Contract AF 33(616) 8888) (WADD-TR-61-132)

AE-32
Aktiebolaget Atomenergi, Stockholm.
STRUCTURE INVESTIGATIONS OF SOME BERYLLIUM MATERIALS.
I. Fäldt and G. Lagerberg. January 1960. 15p.

Metallographic structure, microhardness, and texture were studied on various types of Be materials. It was found that Be exhibited its highest hardness values in directions perpendicular to the basal plant.

ANL 6426
Argonne National Laboratory, Ill.
ELECTRICAL PROPERTIES OF GLASS. A BIBLIOGRAPHY.
Robert Kepple. July 1961, 37p. (Contract W-31-109-ent-38)

ASME Paper 61-AV-42
American Society of Mechanical Engineers
EVALUATION OF THE SHORT-TIME MECHANICAL PROPERTIES OF STRUCTURAL BERYLLIUM. Eugene C. Bernett. 1961, 13p.

Evaluation of the conventional and rapid rate tensile properties and short time high-stress creep properties of Be at 75-1500° F.

ASME Paper 62-AV-14
American Society of Mechanical Engineers,
CRYOGENIC PROPELLANT-TANK STRUCTURES. Jack B. Esgar. 1962, 13p.

ASME Paper 61-WA-282
American Society of Mechanical Engineers
ENVIRONMENTAL FACTORS WHICH INFLUENCE MATERIALS, PROPERTIES AND NUCLEAR REACTOR DESIGN. C. O. Smith. 1961, 12p.

The effects of corrosion, temperature and neutron and gamma irradiation on the mechanical properties including strength, ductility, toughness and thermal expansion for reactor pressure vessel components

made of Au, Li, Fe, Cr, Be, mild and carbon steels, 347 stainless and Inconel.

ASTM Preprint 67

TENSILE PROPERTIES OF BERYLLIUM FROM ROOM TEMPERATURE TO 1600° F. W. J. Salmen and L. P. Gobble. 1962, 12p.

Determination of the modulus of elasticity, yield and ultimate strengths and elongation by testing QMV Be blocks at room temperature to 1600° F using a strain rate of 0.005 in. per in. per min; analysis of the tensile properties and stress strain curves as a function of temperature.

CW-R&DL-1

Canadian Westinghouse Co., Ltd., Hamilton, Ont.
ANNUAL PROGRESS REPORT ON THE BERYLLIUM RESEARCH PROJECT, 1959. W. D. Bennett. April 1960, 65p. For Atomic Energy of Canada Ltd., (AECL-1029)

The work described consisted primarily of evaluating different grades of beryllium by metallographic and x-ray methods and carrying out a series of stress-rupture and tensile tests at high temperatures on the grades which showed some promise. Following these tests, metallographic studies were made on the fracture regions in a search for indications of grain-boundary void formation. Extruded 1/2-in.-diameter beryllium rod was received from two separate sources: Pechiney and Nuclear Metals.

CW-R&DL-14

Canadian Westinghouse Co., Ltd., Research and Development Labs., Hamilton, Ont.
ANNUAL REPORT ON BERYLLIUM RESEARCH, 1960. W. D. Bennett. (February 1961)

DC-58-7-146

Atomics International, Division of North American Aviation, Inc., Canoga Park, Calif.
STRESS-STRAIN-TEMPERATURE-TIME RELATIONSHIPS IN REFRACTORY MATERIALS. R. D. Chipman. July 1958, 40p. For General Electric Co., Aircraft Nuclear Propulsion Dept., Cincinnati. (Contract AT(11-1)-171.

Testing to determine the modulus of rupture and short time creep data for high density, high purity, BeO and SiC bodies at room temperature to 2730° F.

DC-60-4-80

General Electric Co., Aircraft Nuclear Propulsion Dept., Cincinnati.
COMPILATION OF PROPERTIES OF BERYLLIUM INTERMETALLIC COMPOUNDS. G. C. Huth and J. P. Smith. April 1960. (Contract AT(11-1)-171) 15p.

DMIC Memo 105

Defense Metals Information Center, Battelle Memorial Institute
A REVIEW OF RECENT DEVELOPMENTS IN THE METALLURGY OF BERYLLIUM. Webster Hodge. May 1961, 5 p.

DMIC-Memo-142

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio
EFFECTS OF MODERATELY HIGH STRAIN RATES ON THE TENSILE PROPERTIES OF METALS. D. P. Moon and J. E. Campbell. December 1961. 34p.

Effects of increasing the strain rate to nearly 100 in. per in-min. at room and elevated temperatures on the tensile properties of the commercial alloys; Al alloys, Be, steels, stainless steels, superalloys and Ti alloys.

DMIC Rept. 148

Defense Metals Information Center, Battelle Memorial Institute
REVIEW OF CURRENT DATA ON THE TENSILE PROPERTIES OF METALS AT VERY LOW TEMPERATURES. J. E. Campbell. February 1961. 76p.

DMIC Rept. 160

Defense Metals Information Center, Battelle Memorial Institute
INTRODUCTION TO METALS FOR ELEVATED-TEMPERATURE USE. J. E. Campbell, H. B. Goodwin, H. J. Wagner, R. W. Douglas and B. C. Allen. October 1961. 70p.

DMIC Rept. 165

Defense Metals Information Center, Battelle Memorial Institute
METHODS OF EVALUATING WELDED JOINTS. M. D. Randall, R. E. Monroe and P. J. Rieppel. December 1961. 74p.

HW-68747

General Electric Co., Hanford Atomic Products Operation, Richland, Wash.
IRRADIATION EFFECTS IN CORE STRUCTURAL MATERIALS. S. H. Bush. March 1961.

LMSD-48472

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif.
BERYLLIUM DESIGN DATA. April 1959. 84p. (Contract NOrd 17017)

LMSD-89083

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif.
TENSILE FAILURE OF QMV BERYLLIUM FROM ROOM TEMPERATURE TO 870°C. M. I. Jacobson and F. M. Almeter. March 1961.

Correlation of the mechanical properties of hot-pressed Be with BeO content and microstructure. Data are given for elongation, fracture, void formation and nucleation, grain boundary sliding and intercrystalline failure.

LMSD-288139

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif.
ON DETERMINING BIAXIAL-STRESS YIELD AND FRACTURE CRITERIA FOR HOT PRESSED BERYLLIUM AT ROOM AND ELEVATED TEMPERATURE. Paper 6 of GENERAL RESEARCH IN FLIGHT SCIENCES, JANUARY 1959-JANUARY 1960. VOLUME II. MECHANICS OF DEFORMABLE BODIES. R. F. Crawford. 37p.

The classical criteria for yield and fracture strengths of materials in biaxial states of stress must be applied selectively. The proper selection depends upon the particular metallurgical mode of failure

involved, which, even for a given material, depends upon the particular biaxial state of stress as well as other factors. In the case of beryllium added complications can arise from directionalities that are the result of preferred orientation of the grain lattice structure. The above considerations are discussed and modified criteria for yield and fracture are introduced to account for preferred orientations. Recommended testing procedures are presented along with a brief bibliography.

LMSD-288139

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif. THE EFFECT OF RESIDUAL STRESSES ON THE CRITICAL CRACK LENGTH PREDICTED BY THE GRIFFITH THEORY. Paper 13 of GENERAL RESEARCH IN FLIGHT SCIENCES, JANUARY 1959-JANUARY 1960. VOLUME II. MECHANICS OF DEFORMABLE BODIES. W. E. Jahsman and F. A. Field. 23p.

The Griffith theory for unstable crack length is modified to take into account the effect of residual (self-equilibrating) stresses. An expression relating the uniform stress, physical properties of the material, critical crack length, and the equilibrating strain energy is derived for a general residual stress distribution. This expression is used to develop a criterion for spontaneous cracking due to residual stresses alone. A specific numerical example for a parabolic residual stress distribution in a beryllium plate is carried out in some detail.

LMSD-288140

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif. PLASTIC DEFORMATION IN BERYLLIUM. Paper 3 of GENERAL RESEARCH IN MATERIALS AND PROPULSION, JANUARY 1959-JANUARY 1960. VOLUME II. E. C. Burke. 17p

The gross growth structure on electrodeposited beryllium crystals is rationalized on the basis of a Crova disk construction. Beryllium undergoes large amounts of accommodation kinking on the $\{11\bar{2}0\}$ planes without cracking. Evidence is presented that beryllium may twin on planes other than $\{10\bar{1}2\}$. The stereographic projection for beryllium is presented in a standard orientation.

LMSD-288233

Lockheed Aircraft Corp., Sunnyvale, Calif. GRAIN REFINEMENT IN BERYLLIUM BY ALLOYING. D. Crooks and H. Sumsion. Summary Rept. 1, July 1958-December 1959. January 1960, 1 v. incl. illus. tables, (Contract NOrd-17017)

LMSD-480485

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif. VACUUM MELTING OF BERYLLIUM BY ELECTRON BOMBARDMENT. H. T. Sumsion and C. O. Matthews. December 1959, 41p. (Contract NOrd-17017)

LMSD-49735

Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif. STRESS CORROSION CRACKING OF BERYLLIUM. C. M. Packer. May 1959, 23p.

LR-12954

Lockheed Aircraft Corp., Burbank, Calif.
FATIGUE TESTS OF SOME HOT PRESSED BERYLLIUM. R. L. Lowe. March 1958. Revised October 1959. 25p.

Results of fatigue tests completed on specimens that were machined from QMV hot-pressed 1050 beryllium block at frequencies up to 10,000,000 cycles are reported. Additional fatigue tests performed on QMV hot-pressed 1050 beryllium block extended to 100,000,000 cycles are included. Reported also are the results of fatigue tests of 1/8-in. beryllium sheet in which testing was carried out to 10,000,000 cycles.

MIT-1113 (Del.)

Massachusetts Inst. of Tech., Cambridge. Metallurgical Project.
TECHNICAL PROGRESS REPORT FOR THE PERIOD APRIL 1953 THROUGH JUNE 1953. September 1953.

NASA-TN-D-999

COEFFICIENTS OF FRICTION AND WEAR CHARACTERISTICS FOR SKIDS MADE OF VARIOUS METALS ON CONCRETE, ASPHALT AND LAKE-BED SURFACES. Robert C. Dreher and Sidney A. Batterson. January 1962. 34p.

Simulated handings and slideouts were made at forward speeds up to 180 ft per sec. Comparison of coefficients of friction developed by wire-brush skids and softer metal skids with those developed by braked wheels with rubber tires.

NBS-TN- 136

SOME PROBLEMS OF FATIGUE OF BOLTS AND BOLTED JOINTS IN AIRCRAFT APPLICATIONS. Leonard Mordfin. January 1962. 50p.

NMI-1238

Nuclear Metals, Inc., Concord Mass.
IMPURITY EFFECTS IN COMMERCIALLY PURE BERYLLIUM. S. H. Gelles and A. K. Wolff. February 1961. 74p.

Room temperature and elevated temperature results of tensile testing Be rod made from Brush QMV powder show that the tensile properties depend on the extent that impurities are dissolved in the B lattice. Precipitation of an impurity or impurities is responsible for the changes in both electrical resistivity and mechanical properties. Efforts to identify the precipitating phases and the impurities responsible prove unavailing.

NMI-1252

Nuclear Metals, Inc., Concord, Mass.
STABILITY OF THE HIGH TEMPERATURE BETA PHASE IN BERYLLIUM AND BERYLLIUM ALLOYS. J. J. Picket, E. D. Levine, and W. B. Nowak. September 1961. 34p.

NMI-2091

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. PROGRESS REPORT FOR NOVEMBER 1960. December 1960. 28p. (Contract AT(30-1)-1565.

The preparation, β-phase boundary study, and thermal analysis of ternary and quaternary beryllium alloys was continued.

NMI-9502
Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT FOR THE PERIOD APRIL 1, 1960 TO JUNE 30, 1960. S.H. Gelles. July 1960. 25p. (Contract AF 33(616)-7065)

NMI-9505
Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT FOR THE PERIOD JULY 1, 1960 TO SEPTEMBER 30, 1960. S.H. Gelles. November 1960. 94p. (Contract AF 33(616)-7065)

Work is reported on the preparation of pure beryllium metal by the iodide decomposition method. The ultrasonic welding of beryllium to beryllium, aluminum, copper, iron, and titanium is being investigated. An investigation is reported on the role of oxide and voids in beryllium. Work is reported on the factors that contribute to the brittle behavior of beryllium. Work was completed on the effects of surface damage in beryllium. Results showed that surface damage introduced by machining resulted in lower mechanical properties. Removal of the surface damage by chemical etching restored the properties. Work is being conducted to evaluate the room-temperature and elevated-temperature mechanical properties of silver-brazed beryllium lap joints as a function of brazing variables and post-braze treatment. The purification of beryllium by distillation from both liquid and solid phases is reported. A study is reported on aging and strain aging in extruded polycrystalline beryllium rod in terms of mechanical and microstructural parameters. A study is being made of the effect of cold work, alloying, and heat-treatment on the yield strength of beryllium sheet.

NMI-9505
Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT FOR THE PERIOD OCTOBER 1, 1960-DECEMBER 31, 1960. S.H. Gelles. March 1961. 114p. (Contract AF 33(616)-7065)

NMI-9515
Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. QUARTERLY PROGRESS REPORT TO AERONAUTICAL SYSTEMS DIV. FOR THE PERIOD APRIL 1, 1961 THROUGH JUNE 30, 1961. S.H. Gelles. August 1961. 18p. (Contract AF 33(616)-7065)

NMI-9605
Nuclear Metals, Inc., Concord, Mass.
SECOND QUARTERLY REPORT TO WRIGHT AIR DEVELOPMENT DIVISION DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F.M. Yans, A.K. Wolff, and A.R. Kaufmann. May 1960. 28p. (Contract AF 33(616)-6616)

A summary of data is presented from rolling experiments in which the effects of reduction ratio and annealing heat treatments on the structure and orientation of cold-worked beryllium sheet were studied. Texture analysis experiments are also described in which the original and modified Schulz methods of texture analysis are examined, and studies

to determine the relative importance of variables in the rolling process as they affact the structure and orientation of Be sheet are reported. Preliminary conclusions are included.

NP-9242

Franklin Inst. Labs for Research and Development, Philadelphia. DEVELOP HIGH PURITY BERYLLIUM AND DETERMINE THE MECHANICAL PROPERTIES OF MATERIAL PRODUCED. BI-MONTHLY PROGRESS REPORT FOR MAY 1 TO JUNE 30, 1960. Edward Hein, Marvin Herman, and Grant E. Spangler. 7p. (P-A2323-6) (Contract NOas 59-6242-c)

An investigation is presented on the preparation of high-purity beryllium and on its deformation and fracture properties. The beryllium was prepared by zone refining of a beryllium rod, and a tensile test was performed on a single crystal of the zone-refined beryllium.

NP-9274

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif. BERYLLIUM CRACK PROPAGATION AND RELATED STUDIES. SPECIAL BIBLIOGRAPHY. K. D. Carroll, comp. August 1960. 45p. (SB-60-30)

A compilation is presented of information pertinent to surface cracks that develop in beryllium when it is subjected to bending loads, its recovery from stress and bending, and fracture or crack propagation to catastrophic failure.

NP-9662

General Motors Corp. AC Spark Plug Div., Flint, Mich. AN INVESTIGATION OF THE PRECISION MECHANICAL PROPERTIES OF SEVERAL TYPES OF BERYLLIUM. Thomas J. Hughel. April 1960. 28p. (MR-120) (Project No. 23-1010-601)

The mechanical properties of beryllium that are important in gyro applications are discussed. Methods for the measurement of the precision elastic limit and dimensional stability of beryllium are described. Results of the measurements of these properties on six modified forms of beryllium are given. It is shown that fine grain size and high BeO content favor high precision elastic limit and good dimensional stability. It is also shown that the addition of 1% iron as an alloying element improves the precision mechanical properties of beryllium without significantly altering the diamagnetic character. Prestraining is also shown to give large improvement in the precision mechanical properties. The variability of the precision elastic limit of standard production beryllium is shown to be rather large, both within a single pressing and from lot to lot.

NP-10001

Curtiss-Wright Corp. Wright Aeronautical Div., Wood-Ridge, N. J. THE TENSILE, NOTCHED TENSILE AND TENSILE IMPACT PROPERTIES OF CROSS-ROLLED-100 MESH QMV BERYLLIUM SHEET. PROGRESS REPORT NO. 1. September 1960. 102p.

Investigation to 1100°F to determine tensile and notch strengths and brittle-ductile transition temperature range. Tensile and tensile-impact testing to define the relationship between ductility, repeated yielding and change in fracture mode. Fracture behavior is given as a function of temperature and twinning influence is investigated as a mode of deformation.

NP-10211

Brush Beryllium Co., Cleveland

INVESTIGATION OF REFRACTORY METAL BERYLLIDES AND SILICIDES AS VERY HIGH TEMPERATURE MATERIALS. Jonathan Booker, Robert M. Paine and A. James Stonehouse. April 1961. 16p. (Contract AF 33(616)-6540)

Investigation of strength and rupture mechanisms for Ta_2Be_{17} and WSi_2 in the intermediate temperature range. The effect of stoichiometry on the properties of refractory compounds.

NP-10346

Beryllium Corp., Reading, Pa.

DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. THIRD INTERIM TECHNICAL REPORT FOR PERIOD JANUARY 29, 1961 TO APRIL 28, 1961. FINAL PHASE II REPORT. K. C. Taber and E. E. Weismantel. 83p. (Contract AF 33(600)-41959)

Study of statistical consistency of mechanical properties including ultimate tensile strength, formability and yield strength of sheets and bars of Be as a function of thermal treatment, mill and flat rolling history and BeO content.

NP-11184

Beryllium Corp., Reading, Penna.

DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. FOURTH INTERIM TECHNICAL REPORT, MAY 19 - NOVEMBER 13, 1961. FINAL PHASE III REPORT. E. E. Weismangel and K. C. Taber. 66p. (Contract AF 33(600)41959)

NP-11238

Brush Beryllium Co., Cleveland

FABRICATION OF BERYLLIUM FINE WIRE. FINAL REPORT. TECHNICAL REPORT 200-228. A. G. Gross, Jr., R. G. O'Rourke, and W. W. Beaver. April 1961. 62p. (Contract NOas-60-6108-c)

ORNL-3017 (p. 116-24)

Oak Ridge National Lab., Tenn.

RADIATION METALLURGY. O. Sisman, R. G. Berggren, et al.

"... experiments were run to determine the effect of internal helium generation on the physical and mechanical properties of beryllium."

ORNL-3213 (p. 124-133)

Oak Ridge National Lab., Tenn.

NUCLEAR METALS. O. Sisman and W. E. Brundage, et al.

Rupture strength of Inconel, 304 stainless steel, C-1% Zr alloys, Zircaloy-2 and Be. Effects of irradiation on the tangential strain at rupture for Inconel and 304 stainless steel. Influence of boron on the rupture strength of Inconel during irradiation.

P-A2323-4

Laboratories for Research and Development, Franklin Inst., Philadelphia, Pa.

DEVELOP HIGH PURITY BERYLLIUM AND DETERMINE THE MECHANICAL PROPERTIES OF MATERIAL PRODUCED. BI-MONTHLY PROGRESS REPORT, JANUARY 1 - FEBRUARY 29, 1960. Edward Hein, Marvin Herman, and Grant E. Spangler. 5p. (Contract NOa(s) 59-6242-c)

P-A2323-5
Laboratories for Research and Development, Franklin Inst., Philadelphia, Pa.
DEVELOP HIGH PURITY BERYLLIUM AND DETERMINE THE MECHANICAL PROPERTIES OF MATERIAL PRODUCED. BI-MONTHLY PROGRESS REPORT, MARCH 1 - APRIL 30, 1960. Edward Hein, Marvin Herman, and Grant E. Spangler. 3p. (Contract NOa(s) 59-6242-c)

Patent - British 847,992
MAGNESIUM ALLOYS HAVING A HIGH RESISTANCE TO PERMANENT CREEP DEFORMATION AT ELEVATED TEMPERATURES. Hans Joachim Fuchs. January 27, 1959.

A magnesium alloy having high resistance to creep deformation at high temperatures contains 2 to 10% aluminum, 0 to 4% zinc, 0.001 to 0.5% magnesium, and 0.5 to 3% calcium, with copper and silicon impurities not exceeding 0.5% each. It may also contain beryllium up to 0.005%. Other properties which are improved over those of previous alloys are castability, reduced tendency to burn, and reduced crack deformation (especially if the iron content is at least 0.01%); there is no change in corrosion resistance. Four examples of such alloys are given, together with elongation tests at 200°C for times up to 50 hr.

Patent - British 848,269
IMPROVEMENTS IN OR RELATING TO THE FORMING OF BERYLLIUM. Nigel Austin Hill. September 14, 1960. (to United Kingdom Atomic Energy Authority).

PB-161893
Southern Research Institute (Wright Air Development Division)
DETERMINATION OF THE MECHANICAL PROPERTIES OF AIRCRAFT-STRUCTURAL MATERIALS AT VERY HIGH TEMPERATURES AFTER RAPID HEATING. J. B. Preston and J. R. Katus. April 1960. 81p.

Tensile properties of unalloyed beryllium determined at test temperatures from ambient through 1500°F. The short-time elevated-temperature tensile properties are determined for 10 combinations of base materials and coating materials.

PB-171083
Nuclear Metals, Inc. (Wright Air Development Division)
BERYLLIUM RESEARCH AND DEVELOPMENT IN THE AREA OF COMPOSITE MATERIALS. J. Greenspan. July 1960. 121p.

PB-171088
Lockheed Aircraft Corp. (Wright Air Development Division)
BERYLLIUM CRACK PROPAGATION AND EFFECTS OF SURFACE CONDITIONS. C. O. Matthews. July 1960. 197p.

Investigation of the mechanical properties of Be sheet with various surface finishes show that sheets etched to remove surface defects caused by machining have the best properties. The fatigue endurance limit, which is improved by etching, is as high as the static tensile strength.

PB-171809
Cryogenic Engineering Laboratory, National Bureau of Standards (Ballistic Missile Div.)
CRYOGENIC MATERIALS DATA HANDBOOK. T. F. Durham. September 1961. 555p.

R58CAP25

Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.
A REVIEW OF THE PROPERTIES OF MATERIALS FOR ORGANIC COOLED REACTOR COOLANT TUBES. D. G. Boxall and A. R. Daniel. August 1958. 91p.

A review of the neutron absorption, corrosion resistance, irradiation damage, and mechanical properties of Be, Al-Fe alloys, steels, and Al, Mg, and Zr alloys for use in ...

SAE Paper 514A

Society of Automotive Engineers.
ELECTRON BEAM WELDING TECHNIQUES AS APPLIED TO AEROSPACE STRUCTURES. Robert Bakish. 1962. 10p.

SB-60-30

Lockheed Technical Information Center
BERYLLIUM CRACK PROPAGATION AND RELATED STUDIES. K. D. Carroll. August 1960. 42p.

Compilation of 141 entries, most of which are abstracted, covering Be crack propagation, fracture and mechanical properties.

SCNC-322

Sylvania Electric Products Inc. Sylcor Div., Bayside, N.Y.
ISOSTATIC FORMING OF BERYLLIUM. J. Fugardi and I. Sheinhartz. February 1961. 45p. (Contract Nord-17017)

Yield strength, tensile strength and elongation tests on sections of isostatically formed Be.

SSC-137

U.S. Dept. of the Navy, Bureau of Ships
LOW CYCLE FATIGUE OF METALS LITERATURE REVIEW. J. T. P. Yao and W. H. Munse. October 1961. 21p.

Evaluation of data on low-cycle fatigue of metals based on type of test, cycle rate, stress concentration, crack propagation, material property change and method of analysis. Experiments show that the shape of the load-time curve is important in analyzing low-cycle fatigue tests and that the use of strain rather than stress is more desirable because of plastic deformation that takes place during the test.

TID-11535

Superior Tube Co., Norristown, Penna.
THE CONVERSION OF EXTRUDED BERYLLIUM TUBING TO A CLOSE TOLERANCE BORE TUBE. LABORATORY REPORT 1812. A. C. Hood and A. M. Bounds. February 1960. 133p. (For Oak Ridge National Lab. Contract 13X80025)

WADC-TR-478 (Pt. II)

Brush Beryllium Co., Cleveland.
DEVELOPMENT OF WROUGHT BERYLLIUM ALLOYS OF IMPROVED PROPERTIES. PERIOD COVERED: JULY 1, 1958 TO JUNE 30, 1959. John G. Klein, Leslie M. Perelman, and Wallace W. Beaver. September 1959. 128p. (Project 7351) (USAF Delivery Order 33(616)-57-19)

WADD-TR-60-403

Nuclear Metals, Inc., Concord, Mass.
DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET. F. M. Yans, A. K. Wolff and A. R. Kaufmann. September 1960. 93p. (Contract AF 33(616)6616)

Intensity profiles, texture, basal plane population, ductility and reduction area for sheets bidirectionally compression rolled, annealed, worked and heat treated at high temperatures.

WADD-TR-60-404

Reactive Metals, Inc., Niles, Ohio
A STUDY OF THE EFFECT OF ELECTRON BEAM MELTING ON COMPOUNDS AND METALS. R. L. Martin, S. R. Seagle, and O. Bertea. July 1960. 79p. (Contract AF 33(616)-5603)

WADD-TR-60-425

Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio
MECHANICAL PROPERTIES OF BERYLLIUM. A. E. Riesen and R. T. Ault. September 1960. 35p. (AD-249393)

The test procedures and results of a mechanical properties determination program that included tensile, torsion, pin shear, creep rupture, and fatigue data on two lots of beryllium are presented. One lot of material with a BeO content of 1.45% was hot-pressed; the other lot, containing 1.55% BeO was hot-pressed and hot-extruded. Emphasis was placed on the fatigue and creep-rupture data. Fatigue tests were conducted at room and elevated temperatures with stress ratios of $A = \infty$ and 0.67. Both lots of material showed surprising strength under fatigue loading conditions although beryllium's inherent brittleness manifested itself under static loading conditions by brittle factures. The hot-pressed hot-extruded material was uniformly stronger and therefore more desirable for design purposes than the material that was only hot-pressed.

SECTION V. BERYLLIUM METALLURGY

PART O. CORROSION

Bernard, J. and J. Moreau
THE DIFFERENT METHODS OF OXIDATION OF ALLOYS. Memories Scientifiques de la Revue de Metallurgie, v. 59: 161-168 (Mar. 1962) (French)

Classification of selective and simultaneous oxidation of various binary alloys of specified oxygen affinity, at 700-1200°C., in air, rarified oxygen, water vapor, hydrogen or inert gas atmospheres and under conditions of varying pressure and mechanical stresses and crystal structure by means of the morphology of oxidized layer.

Biefer, G. J. and F. H. Krenz
CORROSION OF ALUMINUM-NICKEL-IRON ALLOYS IN HIGH TEMPERATURE WATER. Paper from HIGH PURITY WATER CORROSION OF METALS. National Assoc. of Corrosion Engineers, Houston, Tex. p. 1-16

Effect of minor additions of Zr, Be and Ti on corrosion resistance. Maximum benefit is obtained by the addition of Be and Ti together with or without Zr. The best alloy has the composition 2% Ni, 0.5% Fe, 0.2% Si, 0.2% Ti, 0.05% Be and 0.05% Zr, balance Al.

Blair, R. W., D. L. Johnson and J. P. Morley
METAL BELLOWS SEALS. Lubrication Engineering, v. 17: 470-475 (Oct. 1961)

Bott, T. R.
RECENT DEVELOPMENTS IN MATERIALS OF CONSTRUCTION. British Chemical Engineering, v. 6: 617-620 (Sept. 1961)

Buckle, H.
NEW AERONAUTIC MATERIALS. Technique Moderne, v. 53: 53-64 (July 1961) (French)

Burdese, A.
METAL CORROSION AT HIGH TEMPERATURE DUE TO VANADIC ANHYDRIDE RELATION BETWEEN ACCELERATED OXIDATION RESISTANCE AND CHEMICAL COMPOSITIONS OF ALLOYS. Metallurgia Italiana, v. 53: 370-376 (July 1961) (Italian)

Effect of small quantities of Mn, Mo, Cu, Be and Zr on resistance of refractory alloys and steels to accelerated oxidation. Examination of behavior of alloys and steels with regard to the formation of protective surface layers in the V_2O_5 vapor atmosphere.

Coriou, H.
THE PROBLEMS OF AQUEOUS CORROSION IN THE DOMAIN OF NUCLEAR ENERGY. Corrosion, v. 1: 132-160 (Dec. 1961) (French)

Study of intergranular corrosion, blistering, pitting, stress corrosion and electrochemical corrosion. Effects of irradiation, heat treatment, temperature, surface conditions and impurities on the corrosion of Zr, U, Al and Ni and their alloys, Zircaloy, stainless steels, Be, Mg and Ti in water vapor and air. Effects on mechanical and physical properties.

Darras, R.
LIQUID METALS AS COOLANTS. Energie Nucleaire, v. 3: 128-138 (Mar-Apr. 1961) (French)
"....Solubility of Be, Mg etc... in Na, K and U."

Etris, Samuel F.
CORROSION AND DETERIORATION STUDIES. Materials Protection, v. 1: 10-14 (Apr. 1962)
ASTM survey of outdoor exposure projects used to test Al alloys and coatings, stainless steel, Cu, Mg, Ni, Pb, Sn, Zn, malleable iron and hot dip galvanized and electroplated coatings on Al and steel. Other tests include corrosion testing of electrical contacts and determinations of the corrosivity of plastics, petroleum products and water.

Garber, R. I. and I. A. Gindin
THE PHYSICAL PROPERTIES OF METALS OF HIGH PURITY. Soviet Physics Uspekhi, v. 4: 405-424 (Nov-Dec. 1961) (Translation - AIP)

Greenert, W. J.
HIGH TEMPERATURE SLAG CORROSION OF METALLIC MATERIALS PT. 3. COMPARATIVE RESISTANCE OF MATERIALS. Corrosion v. 18: 95t-102t (Mar. 1962)
Corrosion resistance of Fe, Cr, Ni, Co, Fe-Cr alloys, Cr-Ni alloys, stainless steels, Co complex alloys, Al alloys, Fe-Si alloys, Si alloys, Mn alloys, Be diffused surfaces, ceramics and cermets to vanadium slag, nonsulphated vanadium slag and a sulphate chloride nonvanadium slag.

Hepner, I. L.
SURVEY OF MATERIALS OF CONSTRUCTION FOR CHEMICAL PLANT. CPE(Chemical and Process Engineering), v. 43: 180-184 (Apr. 1962)

Hine, R. A. and R. D. Guninski
HIGH-TEMPERATURE OXIDATION OF ALUMINUM-MAGNESIUM ALLOYS IN VARIOUS GASEOUS ATMOSPHERES. Institute of Metals, Journal, v. 5: (July 1961) 417-422
Oxidation kinetics for Al-Mg specimens in CO_2, Ar, O and dry and undried air studied at 440-540°C. Investigation of oxide film composition, the nature of discolorations and the effects of annealing and of composition including small additions of Be on oxidation mechanisms.

Jepson, W. B.
THE OXIDATION OF BERYLLIUM. Research Applied in Industry, v. 15: 288-294 (July 1962)
A study of oxidation resisting properties of Be using O and carbon dioxide in the presence of water vapor at temperatures ranging from 500-750°C. Influence of reactor radiation, temperature, exposure time and type of gas on the weight gain of Be sheet.

Lowe, A. L. Jr., and E. J. Rozic, Jr.
SCREENING OF LIQUID METAL FUEL REACTOR MATERIALS AND ADDITIVES. American Nuclear Society, Transactions, v. 2: 24-25 (June 1959)
Corrosion resistance and mass transfer of 2 1/4 Cr-1 Mo steel, Be, Mo and Ta are studied in liquid Bi.

Lucas, A. G.
COATINGS PROTECT MATERIALS FROM FLIGHT HEAT. SAE Journal, v. 69: 78-79 (Mar. 1961)
Use of static and ablatine coatings to protect graphite and Mo and other refractory metals from oxidation during aerodynamic heating. Mo is protected by $MoSi_2$ and graphite by a composite of graphite, $MoSi_2$ and graphite by a composite of graphite, $MoSi_2$ and TiB. Ablatine coatings in use include phenolic-asbestos, epoxy-fiberglass and molded Teflon.

Maak, Fritz
INVESTIGATION OF OXIDATION OF COPPER-BERYLLIUM ALLOYS AT ELEVATED TEMPERATURES. Zeitschrift fur Metallkunde, v. 52: 538-545 (Aug. 1961) (German)
Oxidation of pure Cu sheets at 750-1050°C. and of Cu-Be alloy sheets containing 0.77-12.6 at. % Be at 850°C. by air. Continuous measurement of oxidation rate by suspension of specimens on a balance and investigation of oxide structure and oxidation mechanism by microscopic investigation.

Maak, Fritz
EVALUATION OF FILM THICKNESS MEASUREMENTS ON BINARY ALLOYS WITH INTERNAL OXIDATION AND SIMULTANEOUS EXTERNAL OXIDATION. Zeitschrift fur Metallkunde, v. 52: 545-546 (Aug. 1961) (German)
Computation of oxygen solubility as a function of diffusion in a binary Cu-Be alloy (0.77-6.6 at. % Be) oxidized at 850°C. by microscopic measurement of zone of internal oxidation.

Mash, Donald R.
PLASMA-ARC SPRAYING OF SPACE-AGE MATERIALS. Western Machinery and Steel World, v. 53: 48-53 (Apr. 1962)

Pardoe, J. P.
EXTRUSION OF METALS FOR NUCLEAR REACTOR APPLICATIONS. Metal Industry, v. 100: 426-429 (June 1, 1962)

Pelzel, Erich
EFFECT OF SMALL BERYLLIUM CONTENTS ON THE PROPERTIES OF REFINED ZINC PRESSURE DIE CASTING ALLOYS. Giesserei, v. 49: 87-89 (Feb. 1962) (German)

Pourbaix, M.
PREDETERMINATION OF CORROSION CONDITIONS FOR METALS AND ALLOYS. Corrosion et Anticorrosion, v. 9: 47-62 (Feb. 1961) (French)
Electrochemical thermodynamics including plotting and interpretation of equilibrium diagrams of stress and pH and predetermination of theoretical corrosion conditions for immunity and passivation of metals. Electrochemical kinetics with experimental determination of curves of stress and current in electrolysis. Application of results.

Raine, T. and J. A. Robinson
THE CORROSION OF BERYLLIUM AND ALLOYS OF BERYLLIUM WITH CALCIUM IN CARBON DIOXIDE. Journal of Nuclear Materials, v. 5: 341-343 (Apr. 1962)

Effect of 0.15-0.4% additions of Ca on the pressure, temperature and time dependence of the corrosion reaction occurring on arc melted and sintered specimens of Be exposed to CO_2 at 6.8-20.5 atm pressure for various times at 70°C.

Seifert, J. W. and A. L. Lowe, Jr.
EVALUATION OF TANTALUM, MOLYBDENUM AND BERYLLIUM FOR LIQUID BISMUTH SERVICE. Corrosion, v. 17: 475t-478t (October 1961)
Tilting capsule and dynamic loop tests determination of the suitability of Ta, Mo and Be for the containment of liquid Bi in a liquid metal fuel reactor. All the materials tested had adequate corrosion resistance at 750 and 975°F. The corrosion resistance of Ta appears to be related to the surface finish and increasing velocity seems to adversely affect the corrosion resistance of Mo + 0.5 Ti.

Sheets, H. E.
THE ENGINEERING OF SUBMARINES. Mechanical Engineering, v. 84: 37-42 (January 1962)

Smeltzer, W. W. and J. M. Perrow
OXIDATION OF METALS. I/EC (Industrial and Engineering Chemistry), v. 53: 319-324 (April 1961)
Review of current studies on the theory of oxidation, metal and alloy oxidation process and metal oxides.

Smith, R.
METALLOGRAPHIC OBSERVATIONS ON THE OXIDATION OF BERYLLIUM IN WET CARBON DIOXIDE. p. 147-56 of FUEL ELEMENT FABRICATION WITH SPECIAL EMPHASIS ON CLADDING MATERIALS. Volume 2. London and New York Academic Press, 1961.

Sprowl, J. D.
THE PRODUCTION AND USES OF ALUMINIZED STEEL. Iron and Steel Engineer, v. 38: 97-103 (October 1961)

Straumanis, M. E.
THE "DIFFERENCE EFFECT" IN CORROSION RESEARCH. Metall, v. 16: 103-107 (February 1962) (German)
Measurement of rate of hydrogen development for closed and open circuits between electrodes of various metals (Al, Zr, Ti, Be) in electrolytes containing HF, HCl or H_2SO_4. Correlation between positive and negative "difference effect" and polarization.

Straumanis, M. E. and D. L. Mathis
THE DISINTEGRATION OF BERYLLIUM DURING ITS DISSOLUTION IN HYDROCHLORIC ACID. Less-Common Metals, Journal, v. 4: 213-215 (April 1962)
A vacuum cast and a powder metallurgy material (1.2% BeO) are dissolved in HCl and anodically in a Na-Cl solution with x-ray and metallographic observation of the formation of black crystal fragments (needles) and larger fragments resembling twins by a disintegration process.

Straumanis, M. E. and D. L. Mathis
THE DISSOLUTION REACTION AND ATTACK OF BERYLLIUM BY HF, HCl AND H_2SO_4. Electrochemical Society, Journal, v. 109: 434-436 (May 1962)

The kinetics of dissolution of Be in various acids is studied by measuring the rate of reaction through the volume of hydrogen evolved. Microscopic examination is made of corroded microstructure of vacuum cast and sintered Be specimens.

Tunstall, John
AIR BEARINGS, PRECISION MACHING PACE BRITISH DESIGN CONFERENCE. Product Engineering, v. 33: 89-90 (January 1962)

Turner, Arthur
MATERIAL CONSERVATION BY METAL DEPOSITION. Production Engineer, v. 40: 665-673 (October 1961)

Uhlig, Herbert H.
CONQUERING THE OUTER SPACE OF CORROSION SCIENCE. Electrochemical Society, Journal, v. 109: 9c-15c (January 1962)
Review of corrosion mechanisms and corrosive effects with prediction of fundamental corrosion research trends. Topics include electrochemical reactions, oxidation and tarnishing kinetics and mechanisms of stress corrosion cracking. Corrosion fatigue and fretting and inhibition. Reference is made to steels and Fe alloys and nonferrous metals.

Wallwork, G. R. and A. E. Jenkins
PROGRESS IN THE STUDY OF GAS-METAL REACTIONS AT HIGH TEMPERATURE. Paper from AUSTRALIAN ATOMIC ENERGY SYMPOSIUM. Melbourne University Press, Melbourne, Australia, 1958, p. 182-185.
Oxidation of Be.

American Electroplaters' Society, Inc., Newark, New Jersey, 1961, 232p.
48TH ANNUAL TECHNICAL PROCEEDINGS.

Canadian Chemical Processing, v. 45: 69-76 (February 1961)
NEW MATERIALS FOR PROCESS UNITS.

Corrosion Technology, v. 9: 68-70 (March 1962)
CORROSION IN THE NUCLEAR POWER INDUSTRY.
Symposium on the corrosion of reactor alloys, covering corrosion and hydrogen absorption of Zircaloy subjected to steam at high temperatures and pressures; corrosion of Inconel and of Cb alloys in pressurized water reactors; oxidation of Be in CO_2 at high temperatures; galvanic corrosion of fuel cans during underwater storage; and high temperature oxidation and ignition of Mg can alloys.

Fonderia, v. 10: 360 (September 1961)
NEW LIGHT ALLOYS FOR DIE CASTINGS. (Italian)

Iron & Steel, v. 35: 139 (April 1962)
MACHINABLE STAINLESS STEEL CARBIDE.

Nuclear Engineering, v. 7, no. 75: 310-312 (August 1962)
WATER REACTORS.
Stress corrosion, fretting and hydrogen pick up in Be, stainless steel, zircaloy, Inconel and 3.5% Mg-Al alloy used in pressure tube nuclear reactors. Design of various types of pressure tube reactors.

Reactor Core Materials, v. 3: Nov. 1960, p. 30-47
CLADDING AND STRUCTURAL MATERIALS.
Data given for corrosion resistance, metal-water reactions, radiation effects, mechanical properties and metallurgical aspects of Al and Ag alloys, Nb, Zr, Yt, Be, Inconel X, Hastelloy X, Hastelloy R-235, stainless and low carbon steels, tungsten oxides, and carboloy.

Reactor Core Materials, v. 4: May 1961, p. 17-27
NSF MODERATOR MATERIALS.
"Review of recent work on graphite, Be metal..."

Reactor Core Materials, v. 4: Aug. 1961, p. 19-25
MODERATOR MATERIALS.
Effect of irradiation temperatures (450-1200°C.) on the contraction of nuclear graphites. Purification, fabrication, etching and X-ray analysis of Be. Determination of the corrosion resistance, mechanical and electrical properties of Be.

Steel, v. 149: Nov. 6, 1961, p. 90.
BERYLLIDE FAMILY HEADED FOR PLEIADES.

Technical News Bulletin (National Bureau of Standards), v. 45: Oct. 1961, p. 178-179
Tests are conducted with sharply notched cylindrical specimens of steel, Al, Cu and Be alloys both clean and coated with dodecyl alcohol. Results indicate that the use of alcohol may significantly reduce the rate of fatigue crack propagation due to the fact that the polar compound forms a film on the metal which prevents a corrosive reaction between the metal and the atmosphere.

AD 259441
Rolla Metallurgy Research Center, Bureau of Mines, Mo.
VAPOR DEPOSITION OF TUNGSTEN ON ROCKET NOZZLE INSERTS.
F. W. Hoertel

AD 271582
Research Chemicals, Inc., Burbank, Calif.
PROPERTIES OF YTTRIUM AND THE RARE EARCH METALS OXYGEN AND ALLOY SYSTEMS. OXYGEN AND ALLOY SYSTEMS. Rept. for Oct. 1959-Oct. 1960 on METALLIC MATERIALS, Bernard Love. Aug. 1961, 179 p. (Contract AF33(616)6829, Proj. 7351) (WADD TR 61-123)

CF-60-4-111
Oak Ridge National Lab., Tenn.
A GALVANIC CORROSION PROBLEM ASSOCIATED WITH THE PREPARATION OF MULTIMETALLIC BERYLLIUM SAMPLES. D. M. Hewette. Apr. 20, 1960.
Defects noted in the microstructure of specimens during vibratory polishing are attributed to galvanic corrosion. Small additions of $NaNo_3$ to the polishing slurrey eliminates the corrosion.

DMIC Memo 102
Defense Metals Information Center, Battelle Memorial Institute
REVIEW OF RECENT DEVELOPMENTS ON OXIDATION-RESISTANT COATINGS FOR REFRACTORY METALS. W. D. Klopp. Apr. 26, 1961, 3 p.

Properties given for corrosion resistant coatings formed by vacuum distillation, electrodeposition, hot dipping on Cb, Mo and Ta. Coatings include Zn, aluminide, beryllide, silicide and Cr alloy.

DMIC Report 169
Defense Metals Information Center, Battelle Memorial Institute
THE EFFECT OF MOLTEN ALKALI METALS ON CONTAINMENT METALS AND ALLOYS AT HIGH TEMPERATURES. M. F. Amateau. May 28, 1962, 54p

Extensive review of literature on the effects of Na and Na-K alloys, liquid Li and liquid and gaseous K, Rb and Cs on the corrosion, and sliding and bearing properties of pure metals and alloys including stainless steel, superalloys and refractory metals. Topics include types of liquid-metal corrosion, factors affecting liquid-metal corrosion and techniques for investigating such.

LMSC-6-90-61-75
Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif.
THE ELECTROLYTIC POLARIZATION OF BERYLLIUM. TECHNICAL REPORT. D. J. Levy. Nov. 1961, 14 p

Electrochemical testing of Be to determine the anodic and cathodic polarization behavior in a number of aqueous electrolytes containing acids, bases, salts, halides, oxidizers and ions capable of forming insoluble Be compounds. Effects of electrolyte composition and current densities on anodic and cathodic polarization, corrosion, failure to develop a Flade potential and on formation of beryllium oxide film.

LMSD-49735
Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
STRESS CORROSION CRACKING OF BERYLLIUM. C. M. Packer, May 15, 1959, 23p

An evaluation of the resistance of beryllium to stress corrosion cracking is presented. In this investigation, stressed specimens of block and sheet beryllium, uncoated and anodically coated, were exposed to a salt spray. Some specimens were also exposed to several aqueous media. During testing, the acidity of these media and the electrode potentials were varied. No stress corrosion cracking occurred after exposure to either the salt spray or to the other aqueous media although some general surface corrosion was observed.

LMSD-288140 Vol. 2
Lockheed Aircraft Corp., Sunnyvale, Calif.
GENERAL RESEARCH IN MATERIALS AND PROPULSION. VOLUME II. METALLURGY AND CHEMISTRY. Technical rept. Jan 59-60 1v. incl. illus. tables.

"Electronic structure of beryllium..."

LMSD-895073
Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif.
HIGH TEMPERATURE CORROSION OF BERYLLIUM IN AIR. W. Bradshaw and E. S. Wright. Jan. 1961, 70 p

Determination of activation energies and observation of spherical blistering and vertical growth during the reaction of anodized Be with air under pressure at high temperatures. Metallographic evaluation of intergranular penetration at 1050°C. Determination of corrosion products other than BeO or BeN by X-ray and metallographic analysis.

NAA-SR-5363

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
CORROSION AND ACTIVITY TRANSFER IN THE SRE PRIMARY SODIUM SYSTEM. H. E. Johnson. Oct. 30, 1961, 42p (Contract AT-11-1-GEN-8.

Physical property changes, radio-activity, microstructure, embrittlement, hydriding characteristics, oxide pickup and fission product activity for a primary system of Na and stainless steel, Zr and Be specimens exposed in the hot and cold legs of a bypass loop in the primary system of the Sodium Reactor Experiment.

NASA-TN-D-769

Atomics International. Div. of North American Aviation Inc., Canoga Park, Calif.
LIQUID-METAL CORROSION RESEARCH IN THE SNAP DEVELOPMENT PROGRAM. M. A. Perlow and J. R. Crosby. p. 33-44.

The development of the three systems SNAP-2, SNAP-8, and SNAP-10 and liquid-metal corrosion conditions presented by each are discussed. The materials selected for core fabrication tests were stainless steels, Hastelloy, Haynes 5, Inconel X, molybdenum, and niobium. Thermal-convection loops were designed to contain the specimens in a NaK environment and to operate at temperatures from 1200 to 1500°F. The duration of testing and type and rate of attack are given for each specimen. An in-core compatibility study was made of beryllium specimens sandwiched between stainless steel 347 and Hastelloy N, both with and without interfaces of chromium and titanium. Results indicated that the chrome-plated beryllium interface withstood corrosion better than the others.

NASA-TN-D-769

Battelle Memorial Inst., Columbus, Ohio
LIQUID AND VAPOR ALKALI-METAL CORROSION AND RELATED RESEARCH. Eugene M. Simons, p. 61-4.

The effects of liquid NaK on metals, alloys, cermets, and ceramics were studied in Inconel-X capsules. Corrosion by NaK in pumping loops was studied in a 500-hr test. Some voids to a maximum depth of 2 mils, surface roughening and deposits were observed. The vapor pressure of rubidium at 650 to 850°K was determined. Corrosion tests were made on stainless steel, Inconel X, tungsten carbide-cobalt systems, beryllium, and silicon steel using rubidium liquid and vapor. The corrosion effects of liquid sodium on tantalum specimens were measured. Methods for continuous monitoring of sodium for oxygen impurities below 10 ppm are outlined. The frictional behavior of sodium-lubricated rubbing surfaces under nonhydrodynamic conditions was studied. Mo-0.5% Ti rods were tested for creep-rupture in potassium vapor. The properties of potassium liquid and vapor were studied.

NMI-2100

Nuclear Metals, Inc., Concord, Mass.
FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Rept., Oct. 1-Oct. 31, 1961. Jan. 15, 1962, 15p (Contract AT(30-1)-2784)

NMI-4377 (Suppl.)
Nuclear Metals, Inc., Concord, Mass.
SPHEROIDIZATION HEAT TREATMENT AND REEVALUATION OF ZIRCALOY-CLAD U-2 w/o Zr ALLOY TUBE NO. 28, EXTRUSION NO. 18388. D. F. Kaufman, R. G. Jenkins, and W. B. Tuffin. July 29, 1960, 38 p (Contract AT(30-1)-1565, Sponsor Agreement No. S-31).

NP-11178
Brush Beryllium Co., Cleveland, Ohio
INVESTIGATION OF REFRACTORY METAL BERYLLIDES AND SILICIDES AS VERY HIGH TEMPERATURE MATERIALS. Progress Report No. 8 for July 1, 1961 to Sept. 30, 1961. Jonathan Booker, Robert M. Paine and A. James Stonehouse. Nov. 10, 1961, 38 p (Contract AF33(616)-6540).

NYO-9187
Nuclear Materials and Equipment Corp., Apollo, Penna.
FINAL REPORT (ON CORROSION AND RADIATION DAMAGE RESISTANT FUEL MATERIAL. Nov. 15, 1959 through Nov. 14, 1960, 130 p (Contract AT-(30-1)-2264)

Patent - U.S. 3,005,706
HIGH STRENGTH ALLOYS OF ZIRCONIUM. D. E. Thomas and S. Kass. Oct. 24, 1961.

Development of a Zr alloy containing 0.1-2.5% Sn, 0.1-2% Fe, Ni or Cr, 0.03-1.0% Be and 0.5% impurities. The alloys combine high strength with resistance to corrosion by water at high temperatures.

Patent - U.S. 3,026,200
METHOD OF INTRODUCING HARD PHASES INTO METALLIC MATRICES. Eric Gregory. Mar. 20, 1962.

R58CAP25
Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.
A REVIEW OF THE PROPERTIES OF MATERIALS FOR ORGANIC COOLED REACTOR COOLANT TUBES. D. G. Boxall and A. R. Daniel. Aug. 25, 1958, 91 p.

A review of the neutron absorption, corrosion resistance, irradiation damage, and mechanical properties of Be, Al-Fe alloys, steels, and Al, Mg, and Zr alloys for use in organic-cooled reactor coolant tubes is presented.

TID-14955
Denver Univ., Denver Research Inst.
INTERMEDIATE-TEMPERATURE OXIDATION OF BERYLLIDES. Monthly Letter Report No. 5, Jan. 1-Feb. 1, 1962. Frank C. Perkins Feb. 8, 1962, 4 p (Contract AT(11-1)-1092)

SECTION V. BERYLLIUM METALLURGY

PART P. INSPECTION AND CONTROL

Anders, Oswald U.
ACTIVATION ANALYSIS FOR PLANT STREAM MONITORING. Nucleonics, v. 20: 78-83 (February 1962)
Neutron activation stream analysis of U, F, Na, Sc, Ge, Se, Be, Rb, Y, Rh, Ag, In, Er, Yb, Hf, W, Ir and Au. Use of Ra-Be as an irradiation source and a NaI(Tl) scintillation counter.

Apple, R. F. and J. C. White (Oak Ridge National Lab., Tenn.)
SEPARATION AND CALORIMETRIC DETERMINATION OF TRACE QUANTITIES OF MAGNESIUM IN HIGH-PURITY BERYLLIUM OXIDE. Talanta, v. 8: 419-25 (June 1961)
Absorbance method in which Be is separated from Mg by forming Be perfluorobutyrate which is then extracted with diethyl ether. Mg is then measured spectrophotometrically as the high colored complex with Magon.

Barnby, J. T.
MICROCRACKS IN BERYLLIUM. Institute of Metals, Journal, v. 90: 271-272 (March 1962)

Berg, Richard T.
FLUOROSCOPY GOES ON THE LINE. American Machinist/Metalworking Manufacturing, v. 106: 100-102 (May 1962)
Measurement of the sensitivity and resolution of Ti and steel bars, billets using gamma-ray intensifier and vidicon tube techniques in the nondestructive determination of blowholes and inclusions.

Bisson, Andre and Henri Frisby
ELECTRON MICROSCOPE OBSERVATION OF POROSITY, CARBON INCLUSIONS AND DISLOCATIONS IN BERYLLIUM OXIDE SINTERED UNDER LOAD. Journal of Nuclear Materials, v. 4: 133-142 (July 1961) (French)

Blackburn, G. F. and F. R. Caldwell
REFERENCE TABLES FOR 40% IRIDIUM-60% RHODIUM VERSUS IRIDIUM THERMOCOUPLES. Journal of Research (National Bureau of Standards), Engineering and Instrumentation, v. 66C: 1-12 (January-March 1962)

Coleman, R. F.
THE DETERMINATION OF OXYGEN IN BERYLLIUM BY ACTIVATION ANALYSIS. Paper from DETERMINATION OF GASES IN METALS. Iron and Steel Institute, London, England, 1960, p. 93-102.
Be samples are irradiated in a flux of atomic particles to form unstable radioactive isotopes which decay at a characteristic rate. Activity is proportional to the amount of oxygen in the sample.

Everett, M. R. and G. E. Thompson
A STUDY OF THE DETERMINATION OF OXYGEN IN BERYLLIUM BY VACUUM FUSION. Analyst, v. 87, no. 1036: 515-529 (July 1962)
Determination of oxygen in Be and Fr at 1900°C by using vacuum fusion apparatus, vacuum diffusion pump, degassed graphite crucible and a bath of molten Pt.

Green, I. R., J. E. Still, and R. C. Chirnside
DETERMINATION OF CARBON IN THE LESS COMMON METALS AND IN HIGHLY ALLOYED STAINLESS STEELS. Analyst, v. 87, no. 1036: 530-538 (July 1962)
Carbon content in Mo, W, Si, stainless steel, Ni alloys, Zr, U, Ti and Be is determined at 1500°C, using induction and resistance furnaces and Pb, Cu, Cu-Fe and Fe-Cu fluxes.

Kallmann, Silve and Fred Collier
DETERMINATION OF OXYGEN IN BERYLLIUM METAL BY THE INERT GAS FUSION METHOD. Analytical Chemistry, v. 32: 1616-1619 (November 1960)
Fusion of the sample in the presence of carbon and molten Ni reduces the oxygen to CO which is removed from the furnace with argon, oxidized to CO_2 and measured conductometrically in $Ba(OH)_2$ solution.

Kida, Katsuzo, Mitsunobu Abe, Susumu Nishigaki, and Takeshi (Nippon Gaishi Co., Ltd.)
COLORIMETRIC RAPID DETERMINATION OF SILICON IN COPPER-BERYLLIUM ALLOYS. Bunseki Kagaku, v. 10: 358-62 (April 1961) (Japanese)
Composition analysis by an absorbtion method in which the sample is dissolved in H_2SO_4 and H_2O_2, heated and diluted in a solution of ammonium molybdate, HF and ferrous ammonium sulphate. The absorption of molybdenum blue is measured at 750 microns.

Kida, Katsuzo, Mitsunobu Abe, Susumu Nishigaki, and Kazuo Kobayashi
COULOMETRIC DETERMINATION OF Be IN Be-Cu AND Be-Al ALLOYS. Japan Analyst, v. 9: 1031-1035 (December 1960)

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PHOTOMETRIC DETERMINATION OF TIN IN IRON, STEEL AND ORES. Japan Analyst, v. 10: 1335-1340 (December 1961) (Japanese)
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BEARING MATERIALS AND LUBRICANTS FOR HIGH TEMPERATURES. Engineers' Digest, v. 23: 83-84 (May 1962)

Leszynsk, Werner
FOURTH INTERNATIONAL PLANSEE SEMINAR (Held in Tyrol, Austria, on June 20-24, 1961). Journal of Metals, v. 13: 746-751 (October 1961)

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THE STATUS OF BERYLLIUM METAL IN NUCLEAR REACTORS. PT. 1. Atompraxis, v. 8: 122-128 (April 1962) (English)

Review of the properties of Be metal in terms of nuclear engineering, with data given for nuclear properties including absorption cross section, moderating ratio and irradiation behavior; mechanical and physical

properties with particular emphasis on brittleness; compatibility with reactor coolants, fuel and structural materials and health and safety aspects including the toxic nature of Be.

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SCREENING OF LIQUID METAL FUEL REACTOR MATERIALS AND ADDITIVES. American Nuclear Society, Transactions, v. 2: 24-25 (June 1959)

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HEAVY PRESSES IN THE SPACE AGE. Mechanical Engineering, v. 83: 44-45 (September 1961)

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METALLIC AND CERAMIC MATERIALS FOR AIRCRAFT AND MISSILE ENGINEERING. Metall, v. 14: 1182-1189 (December 1960) (German)

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ASPECTS OF THE METALLURGY OF URANIUM AND CONSTRUCTIONAL METALS. Soviet Journal of Atomic Energy, v. 6: 69-72 (September 1960) (Translation-ConBur)

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MATERIALS FOR ASTRONAUTIC VEHICLES. College of Aeronautics, Cranfield, England, 1960, 21p.

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MATERIALS FOR NUCLEAR ENGINEERS. Interscience Publishers Inc., New York, 1960, 373p.
Compatability of . . . Be and Zr.

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BONDED COMPONENTS IN ROCKET MOTORS. Aerospace Engineering, v. 21: 70-71, 86, 88-89 (May 1962)

Paprocki, Stan J. and Ronald F. Dickerson
REACTOR – MATERIALS PROPERTIES. Nucleonics, v. 18: 154-161 (November 1960)

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EXTRUSION OF METALS FOR NUCLEAR REACTOR APPLICATIONS. Metal Industry, v. 100: 426-429 (June 1962)

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CLADDING MATERIALS. Chapter 7 from NUCLEAR REACTOR FUEL ELEMENTS – METALLURGY AND FABRICATION. Interscience Publishers, New York, 1962, p. 231-256.
Comparison of cladding materials in use. Of the reactions currently in operation and under construction some 54 use Al or its alloys, 24 use stainless steel, 13 use Mg or its alloys, 9 use Zr or its alloys and 1 each use graphite, Ni, Be, Cb and V.

Poulsen, S. C.
SPRING STRIP PREPARATION AND SPRING MANUFACTURE. Machinery (London), v. 98: 947-951 (April 1961)
Production of coil springs from carbon steel, stainless steel or beryllium copper strip. Heat treatment and torque testing of finished springs. Corrosion resistance, surface finish and mechanical properties.

Reynolds, Harry L.
MATERIALS FOR NUCLEAR RAMJETS. Metals Engineering Quarterly, v. 2, no. 3: 1-4 (August 1962)
Material requirements for the airframe are similar to those of any supersonic airframe. The reactor is made of a homogeneous mixture of beryllium oxide and uranium oxide. These ceramic pieces operating above 2000°F are held together by Ni-base alloys and cooled refractory metals such as Mo and Cb. Materials, requirements and performance.

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Ross, S. T.
ENGINEERS PUSH SPACE ALLOYS TO THEIR UPPER LIMITS. Iron Age, v. 190, no. 10: 66-69 (September 1962)
Design and engineering analysis of the fabricability and strength of Mg-Li alloys, Be, Ausformed and Maraging steels and TZM Mo alloy as materials for space applications.

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STUDIES ON PLUTONIUM AT CHALK RIVER. Chapter 7 from THE METAL PLUTONIUM. The University of Chicago Press, Chicago, Illinois, 1961, p. 70-78.

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MATERIALS FOR MISSILE CONSTRUCTION. Dechema Monographien, v. 39, no. 600-615: 1-23 (1961) (German)
Review of physical and mechanical properties and application of materials for missile construction including Be, Mg and Al; hardenable, age hardenable, stainless and toolsteels; superalloys having Fe-Ni, Ni and Co-base; refractory metals Mo, Cb, W; and nonmetals such as cermets, ceramics, graphite, plastics and compound materials.

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BERYLLIUM: BEST BET FOR GYRO STRUCTURES. Space/Aeronautics, v. 35: 73-74, 76 (March 1961)
Evaluation of Be as a gyro material, tensile modulus of elasticity, density, coefficient of thermal expansion and thermal conductivity of gyro materials such as 52-100 steel, chrome magnet steel, silicon steel, Al, Mg, stainless steel, Inconel and Be. Physical and mechanical properties and fabrication of Be.

Seala, E.
COMPOSITE MATERIALS FOR THERMAL PROTECTION. Metals Review, v. 33: 4-9 (November 1960)
Physical properties of composites of Be, Cu, Ni and stainless steel and graphite for aircraft hot structures requiring high temperature strength.

Sheets, H. E.
THE ENGINEERING OF SUBMARINES. Mechanical Engineering, v. 84: 37-42 (January 1962)

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SEARCH FOR A NUCLEAR THERMIONIC EMITTER. Nucleonics, v. 19: 66, 70, 72-73 (December 1961)

Terai, Shoji

CREEP PROPERTIES OF 18-8 Cb STAINLESS STEEL. Tetsu-to-Hagane (Iron and Steel Institute of Japan, Journal), v. 46: 379-381 (March 1960) (Translation)

Effect of Cb and Ti on creep rupture properties. Stress versus rupture time relationship with smooth as against notched specimens; effect of temperature of solution treatment; differences in creep versus time under load relationship between 18-8 Cb and 18-8 Ti steel annealed at various temperatures.

Tunstall, John

AIR BEARINGS, PRECISION MACHINING PACE BRITISH DESIGN CONFERENCE. Product Engineering, v. 33: 88-90 (January 1962)

Report of the Second British Engineering Materials and Design Exhibition and Conference, reviewing technological progress in steel castings, turbines, hydrodynamic and hydrostatic air bearings, fiberglass and tri-axial ductile Be. The effects of brittleness and intercrystalline failure are given for Be.

Wigotsky, Victor W.

'MATCHED' MATERIALS AND MOVING COPPER CONDUCTORS IMPROVE GYRO PRECISION. Design News, v. 16: 12-13 (September 1961)

Selection of materials for uniform stress and thermal characteristics to increase the precision of a miniature floating gyro having long-term drift stability. Component materials include M50 toolsteel, 52100 steel, Cu and Be. Thermal expansion coefficients of parts result in constant bearing preload.

Williams, L. R. and P. B. Eyre

BERYLLIUM. Paper from MATERIALS FOR NUCLEAR ENGINEERS. Interscience Publishers, Inc., New York, 1960, p. 269-318.

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'LIFE OR DEATH' METALS, UNIQUE PRODUCTION TOOLS FOR PRECISION ESCAPE, SURVIVAL MECHANISMS. Western Metalworking, v. 20: 37-39 (April 1962)

Applications of Al alloys, 4130 steel, 303 and 304 stainless and beryllium copper in precision aircraft parts. Inspection methods.

Wright, J. C.

METALLURGY IN NUCLEAR POWER TECHNOLOGY. Pt. 5. FUEL ELEMENT CANNING MATERIALS. Metal Treatment and Drop Forging, v. 27: 511-517 (December 1960)

Wright, J. C.

METALLURGY IN NUCLEAR POWER TECHNOLOGY. Metal Treatment, v. 28: 77-82 (February 1961)

Comparison of Al, Be, stainless steel and Zr as matrix elements for reactors. Preparation of internally restrained fuel elements by fusion or powder methods.

Wyatt, L. M.

URANIUM DIOXIDE FUEL ELEMENTS FOR NUCLEAR REACTORS. Brit. Power Eng., v. 1, no. 3: 26-32 (August 1960)

The advantages and disadvantages of UO_2 as a fuel-element material were studied. UO_2 showed greater compatibility with H_2O, H_2, and CO_2 than uranium metal; the melting point was higher, and the dimensional stability was greater than the pure metal. It is also cheaper than

the metal. Some disadvantages in using UO_2 were found to be its lower density and low thermal conductivity. A study of its modulus of rupture and thermal expansion also indicated that the rods would crack if their heat output exceeded 25 watts/cm. Because of probable cracking the UO_2 was formed into pellets instead of rods for canning. Three types of canning material are used; these are stainless steel, zirconium, and beryllium. The advantages and disadvantages of each material were investigated. The difficulty of using long lengths of this brittle material for fuel elements resulted in the use of bundles of rods connected together.

Zipkin, M. A.
ENVIRONMENTAL PROBLEMS IN THE DESIGN OF SPACE POWER SYSTEMS. Aerospace Engineering, v. 20: 14-15, 38-43 (August 1961)
Design approaches compatible with environmental affect components of a space power system. Design of a 500 KW closed-cycle nuclear turbogenerator power supply and complications resulting from space environment conditions.

Alluminio Nuova Metallurgia, v. 31: 31-35 (January 1962)
USE OF TITANIUM, ALUMINUM AND MAGNESIUM ALLOYS FOR MISSILES. (Italian)

Australasian Manufacturer, v. 46: 60-62 (June 1961)
DRILLING AND REAMING BERYLLIUM.

Bureau of Ships Journal: 3-6 (July 1962)
METALLURGICAL MATERIALS PROBLEMS. PT. 1.
Study of Al, Be, steel and Ti for use as submarine hull structural materials in terms of modulus of elasticity, density, yield strength shell thicknesses, frame spacing and area. Mechanical properties and composition analysis of current H4 80 steel hull.

Canadian Chemical Processing, v. 45: 78-80 (October 1961)
MINING AND METALLURGY AT LAKE BERNIC – CHEMALLOY MINES THEM MEDIUM RARE.

Chem. & Process Eng., v. 41: 32-3 (January 1960)
METALS FOR THE NEW AGE. I. C. I. ADDS WROUGHT BERYLLIUM TO ITS PRODUCTION OF 'NEW' METALS.
Production methods and safety hazards in the production of beryllium, titanium, and zirconium are discussed. Applications of the metals are given.

Engineering Materials and Design, v. 5: 268-273 (April 1962)
SURVEY OF INDUSTRIAL FASTENERS. PT. 2.
Properties and materials given for industrial fasteners including rivets, pins, bushes, inserts and retaining rings. Application of fasteners in mechanical joining.

Industrial Heating, v. 27: 2503-2504, 2506, 2508, 2510, 2512 (November 1960)
VACUUM AND CONTROLLED ATMOSPHERE HEAT TREATMENTS SPECIALIZED AT METALLURGICAL CONSULTANTS, INC.

Industrial Heating, v. 28: 2257-2258, 2260, 2262 (November 1961)
REPORT OF SYMPOSIUM ON CERAMICS IN NUCLEAR ENERGY. PT. 1.
Abstracts of 13 papers on ceramic fuels presented at the 63rd Annual Meeting of the American Ceramic Society in Toronto, Canada.
(To be continued)

Industrial Heating, v. 29: 48 (January 1962)
ELECTRO-HYDRAULICS TECHNIQUE USED TO FORM METAL.

Industrial Heating, v. 29, no. 7: 1272, 1274, 1276, 1278 (July 1962)
RECENT DEVELOPMENTS IN MATERIALS FOR NUCLEAR APPLICATIONS. PT. 2.

Survey of uranium carbide as nuclear fuel, materials for thermionic converters, molten metal fuels, recent developments in reactor control materials and in beryllium technology. Consideration of properties and fabrication of nuclear fuels and materials.

Iron Age, v. 187: 107 (April 1961)
BERYLLIUM BOLTS GAIN STRENGTH.

Chemical finishes and rolled threads are used to improve transverse ductility, fatigue resistance and shear strength of light weight Be bolts used in aircraft structures.

Iron Age, v. 188: 113-115 (November 1961)
BERYLLIDES: NEW MATERIALS FOR SPACE AGE STRUCTURES.

Journal du Four Electrique: 21-23 (January 1962) (French)
HEAT TREATMENT IN VACUUM IN AN ELECTRIC FURNACE.

Light Metal Age, v. 19: 18 (June 1961)
FABRICATION OF BERYLLIUM AND TITANIUM FOR THE SPACE CAPSULE.

Machinery (London), v. 99: 442-443
METHODS EMPLOYED FOR MACHINING BERYLLIUM IN AN AMERICAN PLANT.

Machinery (London), v. 99: 687-694 (September 1961)
DEVELOPMENTS IN THE FORGING OF MATERIALS FOR SERVICE AT HIGH TEMPERATURE.

Metal Industry, v. 98: 50 (January 1961)
OXIDATION PREVENTION DURING FORMING.

Method of precoating metals used in aircraft production by spraying with Al or Cu to prevent oxidation and material loss during thermal treatment such as hot forming, stress relieving, heat treating or annealing.

Metal Industry, v. 99: 473 (December 1961)
METALS IN SPACE.

Metal Industry, v. 100: 102-104 (February 1962)
FORMABLE SANDWICH PANELS.

Metal Progress, v. 81: 8 (April 1962)
ENGLISH CAN NUCLEAR FUELS WITH STAINLESS STEEL.

Brittle failure of Be on rapid cooling from high to low temperatures has caused a switch from Be to stainless steel. Stainless offers the possibility of high fuel temperatures, thinner fuel cans and longer burnups.

Metal Progress, v. 82, no. 3: 105-109 (September 1962)
NUCLEAR ROCKETS AND RAMJETS CHALLENGE TODAY'S MATERIALS.

Materials problems inherent in space propulsion systems center about the need for reliable predictable performance at very high temperatures in a variety of environments. Examples include refractory fuel elements for a fission-powered rocket engine and homogeneous mixtures

of beryllium oxide and uranium oxide required in fuel elements for a nuclear ramjet.

Metalworking Production, v. 105: 49-50 (May 1961)
HE SPARK-FORMING MOVES INTO PRODUCTION.
"...process is applied to... Ti, Cb and Be-Cu missile and automotive parts."

Mining Journal, v. 257: 681 (December 1961)
PROPERTIES AND USES OF BERYLLIUM.

Missiles and Rockets, v. 8: 21 (May 1961)
MATERIALS MET TEST ALL THE WAY – AS EXPECTED.
Applications of structural and protective metals including Be, Ti, steel and Ni-Co alloys in space capsule. Fusion welded Ti components provide weld strengths exceeding base metal strengths.

Power Reactor Technology, v. 3: 58-65 (September 1960)
GAS-COOLED REACTORS.
Principal characteristics of various gas-cooled reactors with emphasis on properties of fuel materials such as UO_2, UC, graphite and BeO and of cladding materials composed of stainless steel, Ve, graphite and SiC.

Pro-Metal, v. 14: 517 (June 1961) (German-French)
USE OF BRASS AND BRONZE IN CONSTRUCTION OF MICROSWITCHES.
Examples for microswitches of brass or beryllium bronze (380 v. and 10 amp) having a lifetime of 10-50 million switching operations.

Reactor Core Materials, v. 3: 51-60 (August 1960)
SPECIAL FABRICATION TECHNIQUES.
Melting, casting, hot working, cladding, diffusion bonding, extrusion, explosive forming, brazing, welding and nondestructive testing of reactor core materials such as Zr, U, Cb, ceramic coatings and Mo.

Reactor Core Materials, v. 3: 19-27 (November 1960)
MODERATOR MATERIALS.
Effect of refining, melting, casting, electron-beam welding, and fabrication on physical and mechanical properties of Be and Be alloys. Data given for density, hardness UTS, thermal expansion and conductivity, specific heat, electrical resistivity and electromagnetic units of Zr, Yt, Ba and alloy hydrides.

Reactor Core Materials, v. 3: 30-47 (November 1960)
CLADDING AND STRUCTURAL MATERIALS.
"...metallurgical aspects of Al and Ag alloys,.... Be..."

Reactor Core Materials, v. 4: 17-27 (May 1961)
MODERATOR MATERIALS.
"Review of recent work on graphite, Be metal..."

Reactor Core Materials, v. 4: 52-68 (August 1961)
SPECIAL FABRICATION TECHNIQUES.

Reactor Core Materials, v. 4: 21-30 (November 1961)
MODERATOR MATERIALS.
Irradiation studies of UC_2-graphite fuel pellets. Purification, casting, fabrication and joining of Be. Physical and mechanical properties and corrosion and irradiation behavior of Be. Analysis of thermodynamic studies of ZrH_2, ZrD_2, LiH, scandium hydride and magnesium hydride.

Steel, v. 149: 90 (November 1961)
BERYLLIDE FAMILY HEADED FOR PLEIADES.
Compounds of Be with Ta, Zr, Cb or similar refractory metals are fabricated to produce high temperature (3000°F) and oxidation resistant materials for space applications. Fabrication techniques include vacuum hot pressing, cold and isostatic sintering, slip and investment casting and plasma spraying. Thermal properties and high temperature strengths for the intermetallics are compared above refractory metals, Mo and W, with oxidation resistance and weight being comparable to ceramics.

U.S. Atomic Energy Commission, 1960, 83p.
CIVILIAN POWER REACTOR PROGRAM. PT. 3. STATUS REPORT ON GAS-COOLED REACTORS AS OF 1959.
Development of enriched fuel, gas-cooled reactor power plants. Discussion on reactor physics, heat transfer and fluid flow, core materials, components, plant design and construction and hazards. Core materials discussed include graphite as a moderator, magnox, stainless steel, Be and graphite for fuel cladding and uranium metal and alloys. Bulk UO_2 and UC dispersed in graphite for fuel.

Union Carbide Metals Review, v. 4: 10-12 (Fall 1961)
MERCURY METALS — "A-OK".

Welding and Metal Fabrication, v. 29: 406-408 (October 1961)
FLASH-BUTT WELDING WHEEL RIMS.

Western Metalworking, v. 20: 27-29 (March 1962)
ELECTRON BEAM JOINS 35 METALS IN B-70 PROGRAM.

AD-243448
Brush Beryllium Co., Cleveland
FABRICATION OF BERYLLIUM FINE WIRE. PROGRESS REPORT NO. 2, JUNE 1, 1960 TO AUGUST 1, 1960. A.G. Gross, R.G. O'Rourke, and W.W. Beaver. 13p. (Contract NOas 60-6108-c)

AD-248985
Materials Advisory Board, National Research Council, Washington, D.C.
STATE-OF-THE-ART REPORT BY THE PANEL ON FORGING AND EXTRUSION OF THE COMMITTEE ON THE DEVELOPMENT OF MANUFACTURING PROCESSES FOR AIRCRAFT MATERIALS (AMC). October 1960. (Rept. no. MAB-139-M(F3)) (Contract DA 36-039-sc-76436)
Methods were surveyed for forging and extruding aerospace metals. The principal materials, the atmospheres and heating temperatures, the several forming techniques, the maximum and minimum product dimensions, and tolerance approximations are discussed. The materials include the conventional soft metals such as Al, Mg, Cu, and brass, a great variety of high-strength and high-temperature steels, many super alloys containing over 50% alloying material, several reactive metals (Ti, Be, Zr and their alloys), and the refractory metals (W, Mo, Nb, and Ta). The major forming difficulties are associated with refractory metals and the toxicity and atmospheric contamination of the reactive metals. Precision forging, with the exception of turbine and compressor blades, is not economically feasible. Precision extrusion of the softer metals below the recrystallization temperature is used to secure close tolerances and high mechanical properties.

AD-255443

Convair Astronautics, San Diego, Calif.

A THEORETICAL DESIGN STUDY APPLYING BERYLLIUM TO STORABLE LIQUID PROPELLANT ROCKET TANKAGE. R. L. Jones and R. E. Carlson.

A metallurgical and structural design study of sizes, shapes and properties of Be to determine resistance to negative pressure. Test tanks are studied for the relationship of volume, pressure, payload and material on weight of tankage. Be tank material is compared to stainless steel, A110 AT Ti alloy and 5086-H34 Al alloy.

AD-259441

Rolla Metallurgy Research Center, Bureau of Mines, Mo.

VAPOR DEPOSITION OF TUNGSTEN ON ROCKET NOZZLE INSERTS. F. W. Hoertel.

Data on preparation of coated beryllia inserts including effect of tungsten hexachloride flow rate on the uniformity of vapor-deposited tungsten; cracking of beryllia substrates during vapor deposition; and corrosion of uncoated beryllia exposed to reactant gases.

AD-263340

Mellon Inst. of Industrial Research, Pittsburgh, Pa.

THE EVOLUTION OF ULTRA-HIGH STRENGTH STEELS, AND RESEARCH ON MATERIALS AND VARIOUS NOVEL TECHNIQUES OF FABRICATION OF HIGH PERFORMANCE ROCKET MOTOR CASES. G. K. Bhat.

Research on materials (ultra high strength steels, Be and Al wire) and fabrication techniques (filament winding, epoxy resin bonding) for high performance rocket motor cases.

AD-269630

Foreign Tech. Div., Air Force Systems Command, Wright-Patterson Air Force Base, Ohio

BREAKTHROUGH INTO SPACE. V. Parfonov. August 1961. 17p. (Trans. no. MCL-1185/1 of Z Nanize - Sila 10:1-3, October 1960)

Properties of Be, Mo, Cb, Ta and W in relation to heating to 3000°C and materials to be used for space craft applications.

AD-269866

Coordinated Science Lab., U. of Illinois, Urbana

(No title) PROGRESS REPORT FOR SEPTEMBER-NOVEMBER 1961. November 1961. 27p. (Contract DA 36-039-sc-85122)

Analysis of Be spheres for use in gyroscopes. Secondary emission from Au and Mo. Fluorescence and nuclear resonance studies of Cu. Electron diffraction studies of Ge crystals.

AD-271428

Aeronautical Electronic and Electrical Lab., Naval Air Development Center, Johnsville, Pa.

EVALUATION OF COMMERCIAL TYPES OF TEST POINTS FOR AVIONIC EQUIPMENT. FINAL REPORT. P. A. Mingle. January 1962. 5p. (Rept. no. NADC-EL-61120) (WEPTASK no RAV41J001/2021/R008-01-001)

Dielectric strength, inculation resistance, contact resistance, humidity and vibrations tests on commercially available Cu, Be and Ag alloy test points.

AD-271436

Rolla Metallurgy Research Center, Bureau of Mines, Mo.
VAPOR DEPOSITION OF TUNGSTEN AND THE EFFECTS OF PROCESS VARIABLES. MONTHLY PROGRESS REPORT NO. 3. F. W. Hoertel. January 1962. 4p.

Reaction with gases of one graded W-BeO nozzle inserts coated with tungsten.

AD-271508

Aeronutronic, Newport Beach, Calif.
THERMODYNAMIC PROPERTIES OF ROCKET COMBUSTION PRODUCTS. QUARTERLY TECHNICAL PROGRESS REPORT NO. 2. D. L. Hildenbrand and G. P. Theard. February 1962. 24p. (Pub. no. U-1546) (Contract AF 04(611)7422)

Hydrogen production from the reaction of water vapor with Ta heat shields. Mass spectrometric studies of the $BeO-H_2O$ system at 1938°K. Derivation of the heat of formation of $Be(OH)_2$. Mass spectra for the Be-BeO mixture in the presence of water vapor. Thermodynamic functions of condensed BeO. Measurement of the vapor pressure of crystalline BeF_2 by the torsion-effusion method at 810-925°K.

AEPSC-632

American Electric Power Service Corp., New York
PROTOTYPE AND FULL-SCALE POWER PLANTS GAS-COOLED REACTOR PROJECT. PROGRESS REPORT NO. 4. September 1960. 117p. (Contract AT (38-1)-200)

Development and application of the gas-cooled, heavy-water-moderated, pressure-tube-type reactor concept is discussed. Major revisions were made in the reference design of the 50-Mw prototype power plant. The reoriented research and development program resulted in a new reactor design which substitutes beryllium for stainless steel as the fuel cladding material and employs top-mounted vertical control rods. The extremely low moisture content of the CO_2 required for beryllium allowed a more definitive approach to the design of the CO_2 purification system. The steam generator specifications were revised to obtain the most feasible integrity against water and/or steam leakage. Results from the corrosion testing program indicated that the previously selected Croloy materials are not suitable for use in the high-temperature regions of the CO_2 coolant system. The Croloys were replaced in the system by stainless steel. Re-evaluation of the heat cycle economics resulted in a change to the non-reheat cycle for the prototype reference design. Inlet-valve-controlled main CO_2 blowers with constant speed squirrel cage motors were chosen over less economic alternates. A more compact arrangement of the prototype reactor and CO_2 coolant system permitted a reduction in the diameter of the containment vessel. Other changes, particularly the development and incorporation of a conceptual waste handling system, required an increase in the containment length. D_2O and helium blanket purification systems were modified to handle the expected CO_2 leakage into the D_2O moderator through pressure tube joints. A re-estimate of the capital cost of the plant showed a moderate decrease due primarily to the shift to the non-reheat cycle. Revisions of the plant arrangement and further development of the auxiliary, cleanup, and waste handling systems were included in the revised layout drawings. (For preceding period see AEPSC-623)

ASD-TR-61-322(679-709)
Aeronautical Systems Div., Wright-Patterson AFB, Ohio
CERAMICS AND INTERMETALLICS. J. D. Latva.

ASME Paper 60-WA-316
American Society of Mechanical Engineers
FORGINGS FOR MISSILES AND SPACE VEHICLES. Jose R. Canal and William C. Kunkler, Jr. 1960. 15p.

ASME Paper 60-WA-317
American Society of Mechanical Engineers
ASPECTS OF HEAVY PRESS UTILIZATION. J. Brayman. 1960. 5p.

ASME Paper 61-AV-13
American Society of Mechanical Engineers
ADVANCED FABRICATION TECHNIQUES. R. Garcey, J. Glyman and E. Green. 1961. 19p.

ASME Paper 62-AV-14
American Society of Mechanical Engineers
CRYOGENIC PROPELLANT-TANK STRUCTURES. Jack B. Esgar. 1962. 13p.

Design problems involved in the construction of space vehicle propellant tanks with particular emphasis given to strength-to-density ratios and notch toughness properties of materials.

ASTM Preprint 79
PROPERTIES OF HARDENED COPPER-BERYLLIUM STRIP AFTER EXPOSURES TO ELEVATED TEMPERATURES. K. G. Wikle and N. P. Sarle. 1961. 20p.

Testing at room temperature up to 1150°F to determine tensile and yield strength, proportional limit, elongation and modulus values.

BAW-1100
Babcock & Wilcox.
LIQUID METAL FUEL REACTOR EXPERIMENT – INVESTIGATION OF BERYLLIUM WELDING TECHNIQUES FOR REACTOR PORT THIMBLE JOINTS. P. C. Thys. April 1960. 23p.

BMI-1489 (Rev.)
Battelle Memorial Inst., Columbus, Ohio
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING DECEMBER 1960. Russell W. Dayton and Clyde R. Tipton, Jr. January 1961. 79p. (Contract W-7405-eng-92)

"...gas-pressure bonding of beryllium-clad fuel elements."

BMI-1530
Battelle Memorial Inst., Columbus, Ohio
THE COMPATIBILITY OF GAS COOLANTS AND CERAMIC MATERIALS IN COATED-PARTICLE NUCLEAR FUELS. Arthur Levy and John F. Foster. July 1961. 31p. (Contract W-7405-eng-92)

Investigation of the compatibility of CO_2, CO, steam, air, N and H coolants with C, Al_2O_3, BeO, MgO, Cb_2O_5, SiC, UO_2, ZrC and ZrO_2 to 1500°K. Thermodynamic compatibility is based on the loss of volatile species as calculated from free energy data and Knudsen evaporation rates.

BMI-1545

Battelle Memorial Institute
PRELIMINARY STUDIES OF BONDING OF BERYLLIUM-CLAD UO_2 FUEL ELEMENTS. S. Paprocki. September 1961. 20p.

BMI-N-44

Battelle Memorial Inst., Columbus, Ohio
PROTECTIVE COATINGS FOR BERYLLIUM CARBIDE-BEARING FUEL-ELEMENT BODIES. H. E. Wagner, H. F. Reid, L. S. O'Bannon and C. G. Harman. June 1950. Decl. September 1961. 70p. (Contract W-33-08-ac-14801(16250))

DCL 59-8-93

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati
BeO STANDARDS. R. Cooperstein. August 1959. 19p. (Contract AT(11-1)-171)

DMIC Report 142

Battelle Memorial Institute
ENVIRONMENTAL FACTORS INFLUENCING METALS APPLICATIONS IN SPACE VEHICLES. December 1960. 46p.

Study of the influence of solar, planetary and low-density atmospheres, meteoritic dust, high energy particles, electromagnetic radiation and gravity on metals. Investigation of metals under atmospheric entry conditions and of metals for energy-conversion and utilization systems.

DMIC Report 168

Defense Metals Information Center, Battelle Memorial Institute
BERYLLIUM FOR STRUCTURAL APPLICATIONS. Webster Hodge. May 1962. 152p.

Review of the literature from 1958-1960 on the physical and process metallurgy of Be; included are specifications, tables and graphs of physical, chemical, mechanical and thermal properties.

GA-2262

Brush Beryllium Co., Cleveland
MARITIME GAS-COOLED REACTOR PROGRAM. TECHNICAL FEASIBILITY STUDIES OF FABRICATION TECHNIQUES APPLICABLE TO THE MANUFACTURE OF HIGH-DENSITY BERYLLIA TUBES FOR POTENTIAL UTILIZATION IN THE MARITIME GAS-COOLED REACTOR. FINAL REPORT, MAY 9 TO JUNE 30, 1960. Chester A. Bielawski, Edward A. Douglas and John G. Theodore. 50p. (Contract AT(04-3)-187)

Development of a UOX BeO body, amenable to air firing to high densities with additions of Al_2O_3; investigation of BeO-MgO, BeO-ZrO_2, BeO-SiO_2 and binary additions of MgO-SiO_2, MgO-Al_2O_3, MgO-ZrO_2, Al_2O_3-SiO_2 Al_2O_3-ZrO_2 and ZrO_2-SiO_2; influence of binary combinations on the sinterability; exploratory studies on extrusion, isostatic and cold axial pressing and the slip casting fabrication of beryllia.

GNEC-164 (Del.)

General Nuclear Engineering Corp., Dunedin, Fla.
GAS-COOLED REACTOR PROJECT. PROGRESS REPORT NO. 8, SEPTEMBER 1, 1960-FEBRUARY 28, 1961. March 1961.

A survey of research and development for a prototype gas cooled, heavy water moderated, pressure tube type reactor using finned Be tubing.

HW-68747

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
IRRADIATION EFFECTS IN CORE STRUCTURAL MATERIALS.
S.H. Bush. March 1961.

Influence of reactor environment and irradiation on properties such as fatigue, creep, thermal conductivity, impact-energy transition temperatures, corrosion and tensile strength for structural materials including 300 stainless, 400 stainless, A212B steel, 304SS, 410SS, Inconel-X, Zircaloy-2, Cb, 1100 Al, Be, Magnox, Mg and Ni alloys.

IDO-16648

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho
MATERIALS TESTING REACTOR-ENGINEERING TEST REACTOR TECHNICAL BRANCHES QUARTERLY REPORT, APRIL 1-JUNE 30, 1960. January 1961. 72p. (Contract AT(10-1)-205)

Time-of-flight analyses of Bragg beams from beryllium crystal planes demonstrate the necessity of making such studies prefatory to high precision measurements.

LMSD-48472

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.
BERYLLIUM DESIGN DATA. April 1959.

A handbook provides data on mechanical and physical, joint and fastener, fatigue and dynamic properties for use in the design of parts fabricated from Be.

NAA-SR-Memo-4579

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
COMPARATIVE PROPERTIES OF DISPERSION-ELEMENT COMPONENTS. J. Kroehler, Jr. September 1959. 11p.

Patented fissile materials and matrices available for use in OMR were compared. Thermal conductivities, coefficients of thermal expansion, cross sections, and relative amounts of wt. % contributed to the fuel element were compared for ten matrix materials. The most promising of these appeared to be Al, Be, Mg, and Zr. Uranium contents, absorption cross sections, and relative stabilities were compared for fifteen fissile materials. The most promising of these dispersants appeared to be UC, UO_2, UC_2, UN, and U_2Si_2.

NAA-SR-Memo-5933

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
BERYLLIUM AND ZIRCONIUM ALLOYS FOR Gb-Sr COOLANT TUBE APPLICATION. R.A. Harlow and R.K. Wagner. December 1960.

Literature survey concerning high-temperature strength, corrosion rates, ductility and allowable stress levels for Be and Zr alloys including Zircaloy-2, 321 and 4 at 600-700°F.

NAA-SR-5018

Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.
DISPERSION FUELS FOR ADVANCED ORGANIC MODERATOR REACTOR. J. Kroehler, Jr. June 1960. 44p. (Contract AT-11-1-GEN-8)

An evaluation of previous test results on dispersion fuel element materials indicates that Al, Be, Mg, Zr, and graphite when employed

as matrices and blended into combinations containing 25 to 35 vol. % of the fissile dispersed phase UAl_2, UC, Un, UO_2, or U_3Si_2 exhibit the most promise for advanced organic moderated reactor concepts. Dispersed particle size should be kept large (100 to 200 microns) compared to matrix particle size to confine fission product damage in the dispersant and maintain a continuous matrix. Powder metallurgy methods of fabrication were generally found superior to the melt and cast method. Poor corrosion resistance of Mg and Zr in the organic coolant, low elevated temperature strength of Al and Mg, and the brittleness and poor fission product retention of graphite are discussed. The bonding and diffusion problems associated with several matrix-cladding systems are described. Radiation damage is considered. Various dispersion fuel concepts are proposed.

NBS-TN-136

SOME PROBLEMS OF FATIGUE OF BOLTS AND BOLTED JOINTS IN AIRCRAFT APPLICATIONS. Leonard Mordfin. January 1962. 50p.

A review of literature covering fatigue life of aircraft bolts, nuts and cap screws as influenced by material, thread design, joint design, bolt pattern and operating temperature. Materials covered are alloy steels, Al alloys, stainless steels and superalloys.

NDA-2145-1

Carborundum Co., Niagara Falls, N. Y.
CARBIDE FUEL DEVELOPMENT. PROGRESS REPORT FOR PERIOD OF SEPTEMBER 15, 1959 TO JANUARY 31, 1960. A. Strasser and K. Taylor. March 1960. 22p. (Project IV) (Contract AT(30-1)-2303)

A 6 lb batch of good quality UC was synthesized by the UO_2-carbon reaction. Pellets with densities up to 13.0 g/cc, or 95% of theoretical, were produced by cold pressing and sintering. Hot pressing of UC powder in an aluminum nitride die, rather than graphite die, reduced the reaction with the die material by a considerable factor. Promising results were obtained by limited efforts on the synthesis of UC by the ammonium diuranate-carbon reaction, and the simultaneous reacting and hot pressing of U metal and carbon. Specimens for compatibility tests between UC and prospective cladding materials (Type 304 SS, 2-1/2 % Cr-1% Mo, Inconel X, niobium, and beryllium and Zircaloy-2) were assembled and are being tested at 820°C. The design of irradiation capsules was completed. Dissolution studies of unirradiated UC with simulated fission products showed that 99.97% U recovery is possible.

NDA-2145-5

Nuclear Development Corp. of America, White Plains, N. Y. and Carborundum Co., Niagara Falls, N. Y.
CARBIDE FUEL DEVELOPMENT. PROGRESS REPORT, MAY 1, 1960 TO JULY 31, 1960. A. Strasser and K. Taylor. August 1960. 10p. (Contract AT(30-1)-2303)

Fabrication studies of natural UC were completed. Higher sintering temperatures or changes in binder mixtures did not improve densities. Fabrication of enriched UC for the irradiation tests was completed. An average density of 12.8 g/cc (~94% of theoretical) was obtained, with some as high as 13.1 g/cc (~96% of theoretical). The UC-cladding compatibility tests were completed. The longest tests were 4000 hr at 820°C. Visible reactions occurred between UC and Zircaloy-2, beryllium, Inconel-X, and 2.5 Cr-1 Mo alloy. The plutonium facility is complete and leaktight with all the equipment installed.

NDA-2653-1

Nuclear Development Corp. of America, White Plains, N. Y.
APPLICATION OF BERYLLIUM METAL TO NUCLEAR POWER REACTORS. M. Raber, R. Hankel, and G. Sofer. November 1960. 72p.

A review was made of potential applications of beryllium metal in nuclear power reactor types under development. The results of the study indicate beryllium metal to be economically attractive for use as fuel cladding and core structural material in central station nuclear power reactors, promising significant savings in total energy cost at projected beryllium prices.

NEPA-947

Fairchild Engine and Airplane Corp. NEPA Div. Oak Ridge, Tenn.
COMPOUNDS OF LIGHT ELEMENTS FOR USE AS MODERATORS.
M. E. Lee. April 1949. Decl. July 1961. 42p. (Contract W-33-08-ac-14801(16250))

Fabrication of nuclear moderators from binary alloys and systems of Al, Be, C, N, O, F and Mg with recorded physical and chemical properties.

NEPA-1100

Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.
COMPARATIVE CRITICAL CONDITIONS IN SIMPLE NUCLEAR REACTORS. A. O. Mooneyham. August 1949. Decl. July 1961. 48p. (Contract W-33-08-ac-14801(16250))

NMI-1219

Nuclear Metals, Inc., Concord, Mass.
BERYLLIUM-CLAD URANIUM ELEMENTS, FABRICATION DEVELOPMENT BY MULTI-TEMPERATURE EXTRUSION, AND DIMENSIONAL STABILITY ON THERMAL CYCLING. J. Greenspan. March 1960. 41p. (Contract AT(30-1)-1565)

NP-11196 (p. 16-20)

Canadian Westinghouse Co., Ltd. Hamilton, Ont.
RESEARCH AND DEVELOPMENT IN NUCLEAR METALS. M. J. Lavigne.

NYO-2694

United Nuclear Corp., Fuels Div., New Haven
THE DEVELOPMENT OF URANIUM CARBIDE AS A NUCLEAR FUEL.
H. S. Kalish, F. B. Litton, J. Crane and M. L. Kohn. November 1961. 70p.

NYO-9187

Nuclear Materials and Equipment Corp., Apollo, Penna.
FINAL REPORT (ON CORROSION AND RADIATION DAMAGE RESISTANT FUEL MATERIAL) NOVEMBER 15, 1959 THROUGH NOVEMBER 14, 1960. 130p. (Contract AT(30-1)-2264)

ORNL-3213 (p. 105-124)

Oak Ridge National Lab., Tenn.
FUEL MATERIALS. O. Sisman and J. G. Morgan, et al.

Evaluation of the post-irradiation dimensional stability of Be and stainless steel-canned UO_2 fuel elements, UC_2 dispersed in graphite and UO_2-BeO mixtures at clad temperatures of 1100°F. Influence of heating and cooling on the continuous release of fission gas from UO_2 in both reducing and slightly oxidizing atmospheres.

ORNL-3127

Oak Ridge National Lab., Tenn.

REACTOR CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1961. May 1961.

A progress report with emphasis on: the phase equilibria of molten salts and their reactions with gases, solids and other salt systems; investigation of reactor fuel alloys for thermal stability and corrosion resistance; surface diffusion, gas adsorption and salt penetration of graphite; and investigation of fuel extraction processes.

ORNL-3220 (Pt. 1)

Oak Ridge National Lab., Tenn.

DISSOLUTION OF BeO- AND Al_2O_3-BASE REACTOR FUEL ELEMENTS. PT. 1. K. S. Warren, L. M. Ferris, and A. H. Kibbey. February 1962. 24p. (Contract W-7405-eng-26)

P-1713 (RAND)

RAND Corp., Santa Monica, Calif.

A DISCUSSION OF THE CORRELATION OF CRITICAL CONDITIONS FOR BARE HOMOGENEOUS REACTORS. Benjamin Pinkel and George B. W. Young. June 1959.

A study of reactors using Be, BeO, C, D_2O, Li_7H and H_2O as moderators over a wide range of moderator-to-uranium (U-235) mole ratios.

Patent - Belgian 575,534

Office National d'Etudes et de Recherches Aeronautiques.

MANUFACTURING PROCESS FOR NUCLEAR MATERIALS AND FUELS. Priority date, February 14, 1958. (French)

Uranium-base fuel is combined with plastic Cr for improved oxidation resistance, strength, ductility and thermal conductivity. Fe, Mo, Zr and Al are added to the Cr matrix. The chromizing process is applicable to sintered control rods and to moderator materials containing BeO.

Patent - Belgian 585,959

VITREOUS PRODUCTS FOR USE IN NUCLEAR REACTORS. Compagnie Saint-Gobian. December 30, 1958.

Coating of U-bearing glass granules composed of 30% UO_2, 30% SiO_2, 7% ZrO_2, 7% TiO_2, 12% CaO, 8.5% ZnO, 3% MgO and 2.5% BeO used as fuel in homogenous, heavy water moderated reactors, with a surface layer of magnesium silicate by a 100 to 150 hr treatment with $MgCl_2$ at 100°C.

Patent - British 837,853

IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Jack Williams and William Munro (to United Kingdom Atomic Energy Authority). June 15, 1960.

A method is reported for the production of Be-clad U fuel elements. The U rod is inserted in a hole in the Be body, closing the body with a Be plug, and extruding within the temperature range 420 to 450°C.

Patent - British 873,370

IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Harry Hughes (United Kingdom Atomic Energy Authority). July 26, 1961.

Development of a low-ductility reactor fuel plate having a Be sheath which allows irradiation swelling. The sheath overlaps the fuel plate and the end is welded either together with a space between the plate and weld or to a plug with a clearance between the plug and sheath.

Patent - British 878,911

IMPROVEMENTS IN NUCLEAR FUEL. (to General Electric Co.) October 4, 1961.

Improvement of the thermal conductivity for a UO_2 fuel composition by dispersing UO_2 particles in a matrix of BeO or SiC amounting to 25-40 vol. % of the composition.

Patent - British 882,651

IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Roy Alfred Ulfketel Huddle and Gerald Arthur Hughes (United Kingdom Atomic Energy Authority). November 15, 1961.

Design of a reactor fuel element for heterogeneous reactors in which the neutron expense of a high cross-section canning material is minimized. The element comprises a beryllia moderator hexagonal rod with a uranium-containing plate inserted in each face and clad with stainless steel or chromized mild steel.

Patent - French 1,187,405

FUEL ELEMENTS FOR ATOMIC PILES. (to United Kingdom Atomic Energy Authority). March 2, 1959.

A high-temperature fuel element for gas-cooled reactors is described, consisting of a substantially impermeable graphite tube, a sectional graphite bar which is axially disposed in the tube by means of a number of graphite spacers, a number of graphite sleeves containing fissile or fertile material which are loosely piled up between the spacers, and graphite end reflectors, one of these being provided with a ventilation channel for the removal of fission gases. Seven of these elements are assembled by means of graphite supporting devices. Beryllium may be used everywhere instead of graphite.

Patent - French 1,250,220

ASSEMBLING ELEMENTS, PARTICULARLY NUCLEAR FUEL ELEMENTS. (to Sylvania Corning Nuclear Corp.) November 28, 1960.

Manufacture of fuel elements consisting of a number of parallel sheathed fuel plates held together by two transverse side plates. The fuel plates are placed in grooves in the side plates and bonded at a pressure of about 6 tons per cm on the edges of the side plates. The bond is reinforced by putting SiC, Al_2O_3 or BeO powder in the grooves.

Patent - U. S. 2,981,672

FUEL ELEMENT AND METHOD OF PREPARATION. W. E. Kingston. (to U. S. Atomic Energy Commission). April 25, 1961.

A nuclear fuel element in the form of a wire is reported. A bar of uranium is enclosed in a thin layer of aluminum and the composite is sheathed in beryllium, zirconium, or stainless steel. The sheathed article is then drawn to wire form, heated to alloy the aluminum with both uranium and sheath, and finally cold worked.

Patent - U.S. 2,996,791

METHOD OF MANUFACTURING COMPOSITE ROTOR. E.C. Hicks. August 22, 1961.

Fabrication of rotor structures consisting of an Fe core bonded to a nonpermeable material such as beryllium copper by a method involving die forming of the nonpermeable material around the core and subsequent spraying with molten Fe.

PB161893

Southern Research Institute (Wright Air Development Division) DETERMINATION OF THE MECHANICAL PROPERTIES OF AIRCRAFT-STRUCTURAL MATERIALS AT VERY HIGH TEMPERATURES AFTER RAPID HEATING. J.B. Preston and J.R. Katus. April 1960. 81p.

Tensile properties of unalloyed beryllium...

SAE Paper 514A

Society of Automotive Engineers

ELECTRON BEAM WELDING TECHNIQUES AS APPLIED TO AEROSPACE STRUCTURES. Robert Bakish. 1962. 10p.

SAE Preprint 233-D

MACH 3 WING STRUCTURES STIFFENED SKIN VERSUS SANDWICH. Jack C. Joanides, Stanley C. Mellin and Leslie M. Lackman. 1960. 47p.

Wing structure weight plus insulation is computed for a delta-winged aircraft cruising at Mach 3.0 at 70,000 ft. Wing loadings and insulation represent transport-type mission requirements. Loadings considered spanwise and chordwise bending, transverse and torsional shear and internal pressure. Integrally stiffened wings using AM-355 steel, all-beta Ti alloy and Be are compared with a PH15-7MO steel brazed honeycomb sandwich wing.

SCR-306

Stevens Inst. of Tech., Hoboken, N.J. Powder Metallurgy Lab. DEVELOPMENT OF MILITARY COMPONENTS FROM BERYLLIUM BY SLIP CASTING AND POWDER METALLURGY TECHNIQUES. FINAL REPORT, SEPTEMBER 1959-SEPTEMBER 1960. December 1961. 74p. (Contract AT(29-1)-789)

Vacuum hot pressing and sintering, slip casting, progressive manipulation, cold pressing, extrusion of small, medium, large, hollow, solid or complex components. Microexamination failed to reveal porosity.

TID-7603 (p. 93-106)

U.S. Atomic Energy Commission

CARBIDE FUEL DEVELOPMENT AT NUCLEAR DEVELOPMENT CORP. OF AMERICA. Paper from URANIUM CARBIDE MEETING, PROCEEDINGS. A. Strasser. 1960.

TID-7603 (p. 107-113)

U.S. Atomic Energy Commission

URANIUM CARBIDE RESEARCH AT THE OAK RIDGE NATIONAL LABORATORY. Paper from URANIUM CARBIDE MEETING, PROCEEDINGS. T. Hikido. 1960.

SECTION V. BERYLLIUM METALLURGY

PART R. PLANT EQUIPMENT

Becket, F. J. and P. Burtenshaw
VACUUM HEAT-TREATMENT. Wild Barfield Heat-Treatment Journal, v. 8: 2-9 (June 1962)

Bunshah, R. F.
HIGH POWER ELECTRON BEAMS. International Science and Technology, no 4: 30-38 (April 1962)
Review of the use of electron beams in vacuum melting, zone refining, welding, machining, evaporating, continuous annealing and sintering of refractory metals and their alloys. Consideration of design, precision, focusing accuracy, power densities and operation of an electron beam gun and vacuum chanber, electron beam furnace and an electron beam welder. Purity, quality and precision of ingots and welds produced by electron beam processes.

Cox, John W. and P. Michael Uthe, Jr.
MECHANICAL AND AEROTHERMODYNAMIC DESIGN OF TORY IIA. Aerospace Engineering, v. 21: 8-20 (June 1962)

Russell, D. V.
DEVELOPMENTS IN ELECTRON BEAM WELDING MACHINES. Sheet Metal Industries, v. 39: 495-499 (July 1962)

Sharples, J. T.
ELECTRIC HEATING FOR NONFERROUS METALS. Metal Industry, v. 99: 361-364 (November 1961)

Smith, E. M.
UNIQUE SALT BATH AIDS HEAT TREATMENT OF STRIP. Metal Progress, v. 81: 83-84 (March 1962)

Syre, R.
VACUUM MELTING OF SOME NONFERROUS METALS. Revue de Metallurgie, v. 57: 1107-1116 (December 1960) (French)
"... electron bombardment vacuum melting of Be..."

Wimmer, P. E.
METALLURGY OF ARC WELDING ELECTRODES. Schweissen und Schneiden, v. 13: 140-146 (April 1961) (German)
Metallurgical reactions in welding with basic, heat resistant and high-alloyed electrodes are discussed in terms of reduction, oxidation, gas absorption (hydrogen, oxygen, nitrogen) and mutual reactions between basic and acid slag and metal, solid state precipitations, precipitation hardening and strain hardening. Sulphur sensitivity of electrodes; mechanical properties. Trends in electrode development.

Australasian Manufacturer, v. 45: 36 (January 1961)
LOW COST REVERSING NARROW STRIP ROLLING MILL.
Stainless steel, Ni, Zr, Pt, Be, Cu, rolled Au plate and the bimetals, indium-aluminum and silver-antimony are reduced to thin gages by a two-high, four-high mill. Mill uses work rolls of alloy toolsteel or solid tungsten carbide.

Corrosion Technology, v. 9: 68-70 (March 1962)
CORROSION IN THE NUCLEAR POWER INDUSTRY.

Journal du Four Electrique: 21-23 (January 1962)
HEAT TREATMENT IN VACUUM IN AN ELECTRIC FURNACE. (French)

Light Metal Age, v. 20: 8-9 (February 1962)
MAGNETIC FORMING AND PLASMA FORMING.

Metal Progress, v. 79: 66 (January 1961)
HIGH-TEMPERATURE ALLOYS USED FOR TOOLING.
Waspaloy mandrels used for hot extrusion of beryllium; extrusion dies made from A-286 used for forming of beryllium nickel.

Sheet Metal Industries, v. 39: 316 (May 1962)
ROLLING ULTRA THIN FOIL.

ASME Paper 60-WA-317
ASPECTS OF HEAVY PRESS UTILIZATION. J. Brayman. American Society of Mechanical Engineers, 1960, 5p.

Patent - British 871,715
ARC FURNACE FOR MELTING REACTIVE REFRACTORY METALS. Richard John Fletcher. June 28, 1961.
Melting process and equipment consisting of feeding through a hollow electrode in a liquid, powdered, gaseous, vaporous, flowing or thermolabile condition, a compound of high purity molten Ti, Zr, Ni, Be, Mo, W, Si or Ge that is vaporized or decomposed in the arc of an electric furnace in vacuum.

Patent - German DAS 1,027,808
BOILING WATER REACTOR. R. Schulten. (to Brown Boveri) August 4, 1956.
Blocks containing a mixture of BeO, Th and UO are used to reduce both the volume and the absorption of slow neutrons by the coolant water in a boiling water reactor.

SECTION V. BERYLLIUM METALLURGY

PART S. LABORATORY AND CONTROL EQUIPMENT

Benveniste, J. , A. Mitchell, C. Schrader, and J. Zenger
"VERNI-RAY" – AN INSTRUMENT TO MEASURE THE UNIFORMITY OF THIN FOILS. Review of Scientific Instruments, v. 32: 927-928 (August 1961)

Topographical mappings of the surface density of thin Be foils to an accuracy of 5 mg/cm^2 are measured with the "Verni-Ray", an instrument using an alpha source and a solid-state detector in conjunction with a pulse-height analyzer.

Cahn, Lee and Harold R. Schultz
THE CAHN GRAM ELECTROBALANCE. Paper from VACUUM MICROBALANCE TECHNIQUES. VOL. 2. Plenum Press, New York, 1962, p. 7-18.

An electrobalance, with a capacity in excess of 1 g and a precision of 0.1 microgram uses an elastic ribbon suspension and circuitry which permits long runs without adjustment in high vacuum and at high temperature.

Clegg, A. B. , K. J. Foley, G. L. Salmon, and R. E. Segel
GAMMA RADIATION FROM THE MEDIUM ENERGY PROTON BOMBARDMENT OF LITHIUM, BERYLLIUM, BORON, CARBON AND NITROGEN. Physical Society (London), Proceedings, v. 78: 681-694 (November 1961)

Duggal, V. P. and C. L. Thaper
REMOVAL OF HIGHER ORDERS IN THE THERMAL REGION FROM A NEUTRON CRYSTAL SPECTROMETER. Review of Scientific Instruments, v. 33: 49-50 (January 1962)

Use of a Be single crystal filter to eliminate higher order contamination in the thermal neutron energy range from the monochromatic beam of a single crystal neutron spectrometer employing Ge (111) as monochromators. A 6.4 cm filter suppresses contamination to less than 0.5% in the 0.02-0.06 eV range with primary beam attenuation a factor of 2-3.

Miklavzic, V. , N. Bezic, D. Jamnic, G. Kernel, Z. Milavc, and J. Snajder
TOTAL ABSORPTION OF GAMMA-RAYS FROM 15 TO 27 MeV IN Be. Nuclear Physics, v. 31: 570-574 (April 1962)

Overton, H. L.
LITHIUM-IODIDE SCINTILLATORS FOR FAST-NEUTRON DETECTION. Nucleonics, v. 20: 78-80 (June 1962)

Experiments using a combined field of gamma rays and varying energy neutrons to determine the feasibility of using Li-I crystals with Eu as an activator as fast neutron detectors for the 1-10 MeV. neutron energy range common to Ra-Be and Pa-Be sources. Application to fast-neutron flux oil-well logging.

Ranzetta, G. V. T. and V. D. Scott
STORAGE OSCILLOSCOPE USED IN CONJUNCTION WITH THE SCANNING ELECTRON PROBE MICROANALYZER. Journal of Scientific Instruments, v. 39: 50-53 (February 1962)

Irradiation of Be-Fe (0.4%), U-Ni (25%-50%), Cu-Ni alloys and PuO_2-UO_2 ceramic with high voltage electron with the resulting X-ray

spectra analyzed by an electron probe micro-analyzer and a Remscope storage oscilloscope.

Tsai, Hsian-Shi, Siu-Chung Ho, and K. H. Sun
PHOTOGRAPHY MEASURES SLOW-NEUTRON FLUXES. Nucleonics, v. 20: 60-61 (July 1962)

Vratny, F., M. Dilling, F. Gugliotta, and C. N. R. Rao
INFRARED SPECTRA OF METALLIC OXIDES, PHOSPHATES AND CHROMATES. Journal of Scientific & Industrial Research, v. 20B: 590-593 (December 1961)

Webb, M. S. W., R. J. Webb, and P. C. Wildy
MONITOR FOR THE QUANTITATIVE DETERMINATION OF BERYLLIUM IN THE ATMOSPHERE. Journal of Scientific Instruments, v. 37: 466-471 (December 1960)

Zaika, N. I. and O. F. Nemetz (Inst. of Physics. Academy of Sciences Ukrainian, SSR)
ANGULAR DISTRIBUTION OF PROTONS IN REACTIONS Be^9 (d,p) Be^{10}, Si^{28} (d,p) Si^{29}, AND Bi^{209} (d,p) Bi^{210}. Izvest. Akad. Nauk. S. S. S. R., Ser. Fiz., v. 23: 1460-4 (December 1959) (Russian)

A spectrometer, based on the ionization chamber principle, was developed for measuring proton spectra. The angular distributions of protons corresponding to the excited states of Be^{10} and Si^{29} and the ground state of Bi^{210} are plotted. The silicon and bismuth radii were calculated using the formula $r_0 = (1.7 + 1.22\ A^{1/3}) \times 10^{-13}$ cm, while for beryllium a better result is obtained with the radius equal to 4.8×10^{-13} cm, which is somewhat higher than that obtained by the formula. The spin 0^+ is assigned to the ground state of B^{10} and 1^+, 2^+, or 3^+ to the excited states. The ground state spin of Si^{28} is 0^+ and for Si^{29} has spins $(3/2)^+$ and $(5/2)^+$. The angular distributions from the second, third, and fourth levels were not found due to low proton intensities of the respective groups. Possible spins for the fifth level are $(5/2)^-$ and $(7/2)^-$; and 3.62 MeV the shell model assigns the value $(1/2)^+$. Two characteristic proton maxima are found at 50 and 85° angles from Bi^{209} (d,p) reactions with 14 to 15 MeV deuterons.

Modern Metals, v. 17: 56 (August 1961)
DOUBLE DUTY ANALYZER.

PG-Report-171 (p. 43-54)
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England
ALPHA AND GAMMA IRRADIATION TECHNIQUES FOR BERYLLIUM DETERMINATION. H. Bisby and F. H. Hale.

Portable electronic equipment for geological analysis.